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(INDEX TO VOL. 136)

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CONTENTS. PAGE.

Stellar Energy, Relativity, Gravity, Æther, Photo-Electric Effect 1
By F. H. Loring.
New Short Flame Pulverised Fuel Burner 3
By A Well Known Engineer.
A Glance at the Early Organic History of America 4
By Edgar F. Smith.
Experimental Study on the Combustion Mixtures of Hydrogen with Air or Oxygen in Eudiometer 6
By Torahiko Terada, Kiyohiko Yumoto and Ukitirô Nakaya.
General Notes 7
Proceedings & Notices of Societies:
The Royal Society 8
The Royal Institution of Great Britain 9
International Trade Conditions 12
Improved Industrial Prosperity 13
Forthcoming Events 14
Reviews of Books 15
New Patents 15
New Trade Marks 16

THE CHEMICAL NEWS.

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STELLAR ENERGY, RELATIVITY, GRAVITY, ÆTHER, PHOTO-ELECTRIC EFFECT.

By F. H. LORING.

(*Continued from page 422, Vol. cxxxv*).

IV.

In Section I a glass experiment was cited. A rather better one would be that of making Prince Rupert's Drops, or Dutch Tears as they are sometimes called, the French being *Larmes Bataviques*. These are, of course, produced by dropping molten glass into water, the chilling of the exterior portion of the glass causes a molecular strain, owing to the contraction of the interior which cools last.

When the fine tail of the drop is broken, this operation involving an inappreciable application of energy, the drop shivers, that is to say, breaks into fine particles and a small amount of energy is liberated as heat.

Another known example would be that of whirling a thin circular sheet of paper, so that it becomes a very rigid disc. On striking the disc the paper splinters like glass.

In the case of the æther, it is necessary to consider something quite different, yet the æther is the vehicle for latent energy if the energy of the photo-electric effect is mainly derived from space.

It is also necessary to consider the æther as a transmitting medium for energy quite apart from that which is possibly bound up as latent energy. So far as the writer is aware no satisfactory theory of the æther has been proposed. All analogies are hopelessly inadequate, but they seem to show an energy state that is highly suggestive. In short, the æther appears to be energy in some form.

Recent work in atomic structure has a bearing on these matters as may be judged from the following. A wave-theory of mechanics has been developed, the well-known main contributors to this new phase in physics—involving the atom and the quantum feature discovered by Max Planck — being, L. de Broglie (1925), E. Schrödinger (1926), Heisenberg, Dirac, Born and Jordan.

In this theory Bohr's stationary state, in which the electron describes a circle or ellipse round the atomic nucleus without

emitting radiant energy, is superseded by waves going round the nucleus of the atom, being like a standing wave in sound. Such a wave phenomenon has been called a stationary wave. This is not all, for ordinary light waves that produce the spectral lines are like beats, involving overtaking waves.

To talk about waves " running round in *a circle " calls to mind an idea of this kind* suggested by the writer (see *Chemical News*, Dec. 7, 1923, and some previous issues), to explain the stationary state involved in Bohr's theory (see below). The mathematical development of this theory has aroused much interest.

In the *Daily Mail* of October 18, 1927, Prof. Charles Nordmann (chief astronomer to the Paris Observatory), gave in simple language the gist of this new theory as the following excerpts will show :— " Planck and Bohr have conclusively proved that many optical phenomena can only be explained if the emission of light is not continuous, as Huyghens would have it, but discontinuous, as Newton argued. . . . . In short, light is composed of waves, as Huyghens said, but with a granular structure, as described by Newton. It is not a series of material projectiles and cannot be compared to the *discontinuous* line of bullets fired by a machine-gun firing ball cartridges, but, on the other hand, it may be likened to the series of relatively immaterial explosive waves created by a machine-gun firing blank cartridges. M. Louis de Broglie's happy and surprising discovery appears to conciliate the opposing *theories and to associate in a simple manner* matter and radiation. *The ' quanta ' or the successive waves which constitute light, are, he points out, in reality material particles which themselves are nothing more than small localised wave systems all of which are on the move.* Electrons are the ultimate material particles which gravitate like planets around the centre of all atoms. If these particles are from light waves*, how can we explain that in the ordinary and non-incandescent atoms the particles do not continuously emit light? The reason is, says M. Louis de Broglie, that when the electronic corpuscle is not free, but is bound to an atom around which it describes a closed orbit, the wave which it carries associated with it is itself enclosed. It is stabilised and becomes a *stationary wave* and does not, therefore, emit light. It ceases to radiate and resembles the *stationary waves* noted in acoustics. In other words, there is a simple relation between the period of vibration of the waves which convey the corpuscles and the† atoms and their period of revolution." The oignal may be consulted for more information.

* *i.e., form* light waves.—F.H.L.

It will be seen that the spreading idea given at the end of Section *III* begins to look feasible from the point of view of the new wave-mechanics, but the whole subject is still one of deep mystery.

A recent paper in the *Physical Review* of November, 1927, by A. J. Dempster and H. F. Batho (p. 644) is no doubt important, for these investigators show that when quanta are emitted from atoms they spread and obey the classical laws of undulatory light, *i.e.*, the wave-theory.

That waves of light may be associated with electrons (see Nordmann above) was discussed by the writer in the *Chemical News*, February 22, 1924.

Having referred above to an early article by the writer (1923) it will not be out of place to quote from this paper the views then recorded in these columns :—

The Heaviside layer, which is supposed to cause Hertz waves to conform to the general contour of the Earth, is discussed in the light of Vegard's theory that the higher regions of the atmosphere contain minute positively charged crystals of nitrogen, but it is suggested that these waves may tend to describe a ground orbit round the Earth, because orbital phenomena do not depend upon the mass of the circulating body, as is evident from the fact that the five Balmer lines of the hydrogen atom are linearly related to the groupings of the elements in the periodic table, to the radial positions of five consecutive planets of the Solar system, and the many-lines spectrum of molecular hydrogen is possibly related to the distribution of the asteroids. This leads to the idea that the Bohr orbits are closed-radiation orbits, which only give rise to emission lines when the electron is displaced so as to allow the radiation to expand as a radially-directed wave, which conforms in its behaviour after leaving the atom with the undulatory theory of light.

† " and the " I think should read : *around the*, and the period of revolution refers to the corpuscles, not the atoms.—F.H.L.

In discussing Vegard's theory the following comment was made elsewhere in the same article :—

It frequently happens that when theories are first established, there are phenomena involved which coincide in their effects so that the theory is not the whole truth, but only an overlaid truth, which would become modified when more knowledge is brought to bear upon the subject.

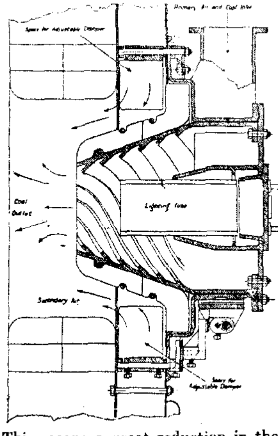
(*To be continued.*)

NEW SHORT FLAME PULVERISED FUEL BURNER.

A NOTABLE ADVANCE.

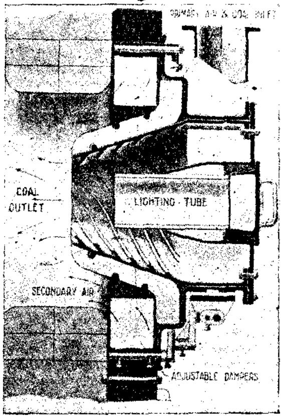
BY A WELL KNOWN ENGINEER.

A solution of the long outstanding problem of flame length in pulverised fuel firing has now been found in a new burner by which the combustion is complete in 10 feet instead of the usual 30 feet. The invention is an achievement of the Research Staff of International Combustion, Ltd., of London, and represents many months of investigation and continuous large scale operation, carried out mainly at Barrow. This new burner is known as the "R" type, and the above short flame operation is obtained with an enormous throughput, up to 150,000,000 B.Th.U., 6 tons of coal, per single burner per hour, as well as very low air pressure.



This means a great reduction in the size and cost of the combustion chamber for large water tube boilers, 50 per cent. less than the present pulverised fuel practice, and it will probably open up an entirely new field with regard to the use of pulverised fuel for cylindrical boilers, not only of the "Lancashire," but also the "Scotch" marine type, as well as many obvious applications in the chemical, glass, ceramic, iron and steel, and general metallurgical industries.

The new burner is on the "turbulent" principle, but much improved, the pulverised coal mixed with the primary air at 2″ Water Gauge, 15 per cent. of the total air for combustion, enters at the top of the burner, and passing through it by means of a circular concentric casing, or burner "head," which in the centre has a lighting and inspection tube. The mixture of air and pulverised coal is given a violent turbulent motion by means of a series of internal spiral projections or ribs, while the secondary air at 1″ W.G., 85 per cent. of the total, enters by another concentric casing nearer the furnace, behind the first casing, and is given also a violent turbulent motion. The only adjustment necessary in the whole of the burner is one damper or slide on the secondary air supply, and the mixing of the fuel particles and the air is of such an efficient and intimate character that, as stated, the combustion is complete, with 17-19 per cent. CO_2 and no unburnt gas, in a flame of 10 feet only.



A GLANCE AT THE EARLY ORGANIC CHEMISTRY OF AMERICA.

By Edger F. Smith
(*University of Pennsylvania, Philadelphia, Pa., U.S.A.*)

Has the reader ever examined an American text-book on chemistry published a century or more ago, with the thought *of what it might contain on organic* chemistry? This query, probably, will bring the reply that text-books of that early *period, printed anywhere in the world*, present very little relating to this domain of chemical science so vast at present. *Further, it would be queried as to whether* whatever might be observed in those early text-books printed in this country on the *subject would not be a repetition of the* material presented in the publications of foreign lands especially those of England? *This surmise would be perfectly correct.*

Then, it would be discovered that there was not *organic chemistry*. Our fathers had *not reached that thought. For then, vegetable chemistry* and *animal chemistry* embraced what the modern designation, *organic chemistry, includes. Wöhler had* not synthesized urea.

One writer observed :

" *The ultimate elements of vegetable and* mineral matter are fewer, and are peculiarly well known. But the light which is thrown *upon inorganic compounds, by resolving* them into their ultimate elements, is much more satisfactory than any which we can, by the same means, extend to organic products. Ultimate analysis demonstrates between these, a difference, chiefly in the proportions of hydrogen, oxygen, carbon, or nitrogen, of which they are constituted; while in their influence no vitality, they display the opposite properties of the most delicious food, or the most deleterious poison, of delighting or offending our senses in the extreme."

This is not the place to recite the various reactions which were applied to organic substances; yet they were industriously subjected to many and various reagents. That with nitric acid will suffice as an illustration :

Nitric acid has no other effect than to impart oxygen—giving rise to the same products as combustion, a result which ought not to excite surprise, as this acid is, in effect, composed of atmospheric elements, condensed into the fluid form, and containing that principle which is the most active. Owing to the volatility of nitric acid, many substances cannot be completely oxygenated by it, unless after several distillations. Repeatedly distilled from sugar, it produces malic acid first, and finally water and carbonic acid. These ultimate results are inevitably consequent to the ignition of the nitrates with dry vegetable substances—as, in this case, the alkali detains the acid, until the heat is adequate to produce a rapid reaction.

In glancing through American *Manual of Chemistry* for 1825 the following observations on *Indigo* were met :

It is a substance of a deep blue colour, containing about 50 per cent. of pure colouring matter, which is perfectly insoluble in water. When heated it sublimes in the form of a blue smoke, which on condensation ,forms acicular crystals. It is soluble in concentrated sulphuric acid. This solution is usually called *Saxon* or *liquid blue*. It is used as a substantive colour for dyeing cloth and silk. Substances which powerfully attract oxygen render indigo *green*, and by exposure to air, it again acquires a blue colour. In this green state indigo is soluble in the alkalies, and the solution is commonly employed for dyeing calico. A bath for this purpose may be made by mixing one part of indigo, two parts sulphate of iron, and two of lime, in a sufficient quantity of water : in this case the sulphate of iron is decomposed by a portion of the lime. The protoxide of iron thus produced becomes peroxidised at the expense of the indigo, which is rendered green and soluble in the alkaline liquor; cotton steeped in this solution acquires a green colour, which by exposure to air, and washing in water acidulated with sulphuric acid, becomes a permanent blue.

This is not a very stirring description, but the colour had attracted attention, and means for its utilisation were being sought. The spirit of progress was evident, and confirmed by an appended suggestion for the analysis of the indigo to arrive at the quantity of actual colouring matter in various samples. This was roughly ascertained by the successive action of water, alcohol, and muriatic acid upon the submitted sample.

The preceding quotation is from " A Manual of Chemistry " by John White Webster, dedicated to John Gorham, M.D., Erving Professor of Chemistry in Harvard and also to James Jackson, M.D., the Professor of Theory and Practice of Physick in the same University.

In a later edition of Hare's *Compendium*—the edition for 1840—a notable feature is that the space devoted to animal and vege-

table chemistry is much extended and that these names so frequent twenty years earlier are replaced by the designation *Organic Chemistry*. Was this due to a widening influence of Wöhler's urea discovery or to Liebig's work? The author now notes that *carbon* is pre-eminently essential to the constitution of organic bodies and that it had been alleged to perform, in vegetables and animals, a part analogous to that which silicon performs in minerals.

Samuel Guthrie (1831) wrote to Benjamin Silliman:

"I am somewhat chagrined by reading your observations on fulminic acid, etc., to find myself anticipated in what I was about to claim as a discovery of my own, to wit, that fulminic acid could be *transferred* to caustic potash, and a salt obtained from the union; and that that salt, at less than a boiling heat, would be decomposed, and yield *ammonia*." Concluding, "After all, I have only verified M. Liebig's discovery of fulminic acid, and devised a detonating compound of tremendous power, which can be prepared with more safety, and at less expense than detonating silver."

Guthrie was, certainly, pursuing interesting paths and applying most original methods of procedure, so that Silliman justly remarked: "I am impressed with admiration both at his skill and intrepidity."

And this bold experimenter was the same Samuel Guthrie who, in 1831, reading about the Dutch liquid and its physiological relations, conceived that he might obtain chloric ether (Dutch liquid) in greater abundance and at a cheaper cost by distilling together alcohol and bleaching powder. His success was remarkable. He obtained not ethylene chloride (Dutch liquid) but an alcoholic solution of chloroform in great abundance, describing his process in Silliman's *Journal of Science* a little later. He had indeed won chloroform, which therefore may be claimed as an American discovery: for Guthrie was not aware of similar researches by Liebig, Dumas, and Souberain, the latter of whom in 1832 called the product "a new ethereal liquid of a constution unlike any before known to chemists."

To Dumas (1834) we are indebted for its name (chloroform) and for the revelation of its true constitution.

This splendid discovery is so inspiring that Guthrie's own words deserve a hearing:

"Into a clean copper still, pour three pounds of chloride of lime and two gallons of well flavoured alcohol of sp. gr. 0.844 and distil. Watch the process, and when the product ceases to come highly sweet and aromatic, remove and cork it up closely in glass vessels. . . . By distilling the product from a great excess of chloride of lime, in a glass retort, in a water bath, a greatly concentrated solution will be obtained. The new product is intensely sweet and aromatic. By distilling it from carbonate of potash, it will be concentrated and refined. By distilling it from caustic potash, the ether is decomposed and muriate of potash is thrown down, while the distilled product consists of alcohol."

In a second paper Guthrie gives in detail a method for testing the purity of chloroform by agitating it with concentrated sulphuric acid. He was also the first (1832) to publish an account of its therapeutic effects as a diffusible stimulant.

Indeed, in these memorable discoveries he was a benefactor of mankind. Think for a moment of the benign influence of chloroform as an anæsthetic; for

There is
No danger in what show of death it makes,
More than locking up the spirits for a time,
To be more fresh, reviving.

This is a chapter of home endeavour in the organic division of our science in which we may well rejoice. It was written in a now "historical laboratory" located in the wilds of the State of New York, away from seats of learning and remote from the arteries of commerce, by a man of medium stature, slender build, dark complexion, slightly stooping figure and thoughtful mein, whom even the close observer of the throng in New York, in which he frequently mingled, would not recognise as a man whose fame as the discoverer of chloroform, and whose work in other original scientific investigations gave him rank among the eminent men of that early period.

Other instances of the experimental activity of early American chemists might readily be given; indeed, it was the writer's intention to prepare a sketch of the "rise and development of organic chemistry in America," but as he gathered in the bright sheaves they grew in multitude so rapidly that he thought it unjust to try to give them briefly, because they deserved an ample and complete presentation, so he contented himself with "a glance at the early organic chemistry of America."

Why should not some enthusiast in

organic chemistry give himself to assembling and offering the observations made in this branch of chemistry as a separate and distinct chapter? It would repay every outlay of effort. Furher it would show that though the labours of the fathers were crude and of a pioneer character, they were meritorious beginnings, having actual and genuine value.

EXPERIMENTAL STUDY ON THE COMBUSTION OF MIXTURES OF HYDROGEN WITH AIR OR OXYGEN IN EUDIOMETER.

By Torahiko Terada, Kiyohiko Yumoto and Ukitirô Nakaya.
(Institute of Physical and Chemical Research, Tokyo.)

The propagation of combustion of inflammable gaseous mixture in tube has been a subject of numerous experimental researches since the classical works of M. Berthelot, P. Vieille, etc. Recently, extensive investigations made by such authorities as Dixon, Thornton, Wheeler, Bone and others have contributed to a considerable advancement of our knowledge on the interesting phenomena which have important bearings upon different practical as well as theoretical problems of physics and chemistry. It must be, however, remarked that the experiments hitherto made were chiefly concerned with the gaseous mixtures with good inflammability, *i.e*, those which may be completely burnt by a single ignition. As to the behaviour of those mixtures which lie near the limit of inflammability, there seems to remain a domain still very obscure. Besides, the investigation of these mixtures is worth while, since some accidents connected with air-ships or factories are frequently due to the unexpected ignition of such mixtures.

During our recent investigations related with an air-ship accident, we happened to use an eudiometer for roughly determining the percentage of a mixture of hydrogen with air very near the lower limit of inflammability. It was found that the mixture cannot be burnt off by a single ignition by spark, but may be repeatedly ignited by waiting awhile after each time. The flame propagated along the tube was apparently extinguished at a certain distance. Hydrogen contained in the unburnt portion soon diffused through the tube and formed a mixture of a lower percentage which could eventually be ignited by the next spark.

Thence, we were led to make some more systematic studies on the allied phenomena, as it was hoped that these studies may bring something into light which may be utilised for examining the effects of agencies affecting the limit of inflammability. The earlier part of the experiments were made by K. Yumoto and M. Godai during 1923-1924, in the Physical Institute of the Tokyo Imperial University, as a course of research experiments for Third Year Students of Physics. By the kind intervention of Rear Admiral Y. Ueda, a fund was granted from the Imperial Japanese Navy for the continuation of the investigation and, moreover, by the generosity of the scientific staffs of the Physical Institute, a room of the Laboratory and also some of the necessary instruments were placed at our disposal. The experiments were then resumed by K. Yumoto, now a member of the Special Committee for Aeronautical Researches, I.J.N. and U. Nakaya, then Stud. Phys., and continued till the end of March, 1925, when the latter had graduated the University and been appointed a Member of the Institute of Physical and Chemical Research. Though the investigation in the same line is still being continued by Yumoto at the present moment, it was considered convenient to give here a brief summary of the results thus far obtained.

Summary.

1. The modes of propagation of combustion in eudiometer tube are investigated in some details, especially with regard to those low per cent. mixtures of hydrogen with oxygen which are near the lower limit of inflammability, by volumometric as well as photographical methods.

2. The ignition by a single spark is in general not capable of burning off the entire initial volume. The flame is extinguished on the way of propagation. The ratio of the volume burnt to the initial volume is a function of (i) the percentage of the gas mixture (ii) the diameter of the tube, (iii) the initial volume, (iv) the initial pressure. Further, it depends on (v) whether the total volume of gas is constrained to be constant, or allowed to vary during the process of combustion and also on (vi) the volume and shape of the portion of the combustion tube on the other side of the spark gap, *viz.*, on the side opposite to the main part of the tube in which the propagation is studied.

3. By means of photographic method, it is found that the flame front is subjected to a characteristic to and fro motion on the midway of its propagation and the extinc-

tion of the flame is associated with the retrograde motion of the flame front. Comparing the photographical results with the volumometric ones, the chief characteristic anomalies of the volumometric curves are explained.

4. Some theoretical discussions are made in order to explain the photographic results. Comparing the theoretical with the actual traces of flame the variation of pressure behind the flame front is inferred. The retrograde motion of flame observed is attributed to the sudden reduction of pressure brought about by a rapid condensation of water vapour formed by combustion and also by the evaporation from the water initially contained in the tube.

5. Some short-period fluctuations in the velocity of propagation of flame are observed and attributed to the effect of a pressure wave due to the initial ignition passing to and fro within the tube. It is remarked that the wave is suddenly damped as soon as the supposed condensation sets in, probably on account of the acoustical turbidity.

6. Volumometric observations were also made with some mixtures with high per cent. of hydrogen near the upper limit of inflammability. A characteristic difference in behaviour is noticed in comparison with the low per cent. mixtures.

7. Incomplete combustion of very low percentage mixture in a spherical chamber is *studied and the statistical distributions* of the volume burnt and also of the facility of ignition are investigated. The dependency of the volume burnt upon the nature of the spark gap electrodes is remarked.

8. The volnmometric metbod such as here developed is considered to be recommendable as a simple means for investigating the modes of combustion of those mixtures which lie near the limits of inflammability and are often the cause of dangerous accidents connected with many practices handling with inflammable gases.

GENERAL NOTES.

POLISH TRADE IN OCTOBER.

Trade figures reveal an unfavourable balance for October amounting to £536,000, while for the first ten months of the current year imports exceeded exports by £6,577,000. In the same two periods of 1926 favourable balances were recorded amounting to £630,000 and £14,328,000 respectively.

WHOLESALE PRICES IN FRANCE, BELGIUM, GERMANY AND ITALY.

The index number of wholesale prices for France in October shows a decline of 2.1 per cent. from the September level. That for Italy has advanced 0.6 per cent., while the October indices for Belgium and Germany are almost unchanged from the previous month. With the exception of Germany the general indices for October are lower for each country than a year ago, the fall in the case of France and Italy being more than 20 per cent. It should be pointed out that in the case of Italy a new series of index numbers (base 1913 = 100) has been introduced in place of that previously published (base 1920 = 100).

BOARD OF TRADE—EXPORT CREDITS GUARANTEE SCHEME.

Owing to the rapidly increasing use which is being made of the facilities provided by the Government under the above Scheme for the assistance of those engaged in export trade, it has been ofund necessary for the Export Credits Guarantee Department to secure larger and more suitable accommodation, as follows :—" The Manager, Exports Credits Guarantee Department, 9, Clements Lane, Lombard Street, London, E.C.4."

THE CO-OPERATIVE MOVEMENT IN RUSSIA.

We have given considerable attention in the *British Russian Gazette* to the Co-operative Movement of Russia, because we regard it as one of the promising signs of the increase of domestic prosperity. The Co-operative Movement covers the whole of Russia, and there are now over 16,000,000 members. The number of local co-operative societies is in the neighbourhood of 100,000 and it is estimated tbat half the population is supplied to a great extent through co-operative organisations. There are the Consumers' Co-operative Societies, the Agricultural Co-operative Socteties, and the Peasants' Home Industries, as well as various other societies. Through the local Co-operative Society the peasant keeps in touch with the home and foreign markets, sells his produce, purchases his requirements, etc. The trade turnover of the Co-operative Societies in 1925-26 was £1,000,000,000, nearly double that of the previous year. Their foreign trade turnover in 1926 was over £10,000,000.—*British Russian Gazette.*

SOCIETY FOR CO-OPERATION OF SCIENTIFIC & TECHNICAL WORKERS IN THE SOCIALIST CONSTRUCTION OF RUSSIA.

A number of leading scientists in Russia have recently formed a society with the object of helping the regeneration of the country. In the course of an important exordium (a translation of which was published by the *British-Russian Gazette*) the signatories say:

"The majority of technical and scientific men amongst us greeted the October Revolution with hostility. But during the process of development of that Revolution, while working in various Government departments with the opportunity of direct observation of and partcipation in the tense struggle of the Soviet Government to reorganise and raise the standard of the economic and cultural life of the country, a certain number of scientific and technical workers have become familiar with the ideas and principles underlying the Soviet construction, and have become convinced of the ultimate victory of Socialism.

"Faced with the truly colossal problem of building up a Socialistic State, the Soviet Government has many times declared that all efforts to this end would fail without the aid of science and technical knowledge. On the other hand, the exhaustive application of the latest scientific and technical discoveries must inevitably lead to the formation of a State in which all work, freed of its shackles, will become a thing of joy and not a weary task.

"In view of the foregoing we have decided to form 'The Society for the Co-operation of Scientific and Technical Workers in the Socialist Construction in the U.S.S.R. (Ornito).'

"The main idea which has led us thus to unite is the realisation that in a state of society which acknowledges no other class than that of the workers, technical and scientific men cannot remain politically neutral. It follows, therefore, that the main object of the society which we have formed is to unite and organise all the scientific and technical men of the country who sympathise with Socialism. And we call upon all the scientific and technical men of the Union of Soviet Socialistic Republics who share our views to join us."

The manifesto is signed by some 27 professors connected with various Universities and other scientific institutions.

BOARD OF TRADE ANNOUNCEMENT.

Metaldehyde.

The Board of Trade give notice that representations have been made to them under Section 10 (5) of the Finance Act, 1926, regarding metaldehyde.

Section 10 (5) of the Finance Act, 1926, is as follows:—

"The Treasury may by order exempt from the duty imposed by section one of the Safeguarding of Industries Act, 1921, as amended by this Act, for such period as may be specified in the order, any article in respect of which the Board of Trade are satisfied on a representation made by a consumer of that article that the article is not made in any part of His Majesty's Dominions in quantities which are substantial having regard to the consumption of that article for the time being in the United Kingdom, and that there is no reasonable probability that the article will within a reasonable period be made in His Majesty's Dominions in such substantial quantities."

Any person desiring to communicate with the Board of Trade with respect to the above-mentioned application should do so by letter addressed to the Principal Assistant Secretary, Industries and Manufactures Department, Board of Trade, Great George Street, S.W.1., within one month from the date of this notice.

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.

The following papers were read at the meeting held on December 8, 1927:—

On a Photoelectric Theory of Sparking Potentials. By J. Taylor. Communicated by O. W. Richardson, F.R.S.

The paper describes a photoelectric theory of sparking potentials, according to which the latter is a function of the photoelectric emissivity of the cathode for the radiations accompanying the neutralisation of the positive ions at the cathode surface. It is assumed that no ionisation by collision is produced by the positive ions in the gas.

Adopting the Townsend theory of ionisation by collision by electrons, the following expression is arrived at for the sparking potential v_e (plane parallel electrodes):—

$$v_e = \frac{X}{a} \log \frac{1-\gamma}{\gamma},$$

where X is electric field (volts per cm.), α number of electrons produced per cm. by one electron, by collision, and γ number of electrons produced at cathode by neutralisation of one positive ion.

The validity of the theory is examined for the case of helium, which can be thoroughly purified by means of charcoal in liquid air. The results show definitely that the sparking potential is a continuous function of the photoelectric emissivity of the cathode for the radiation emitted by the gas. The quantitative agreement with the above equation is very good.

The Spectrum of Doubly Ionised Oxygen (O III). By A. FOWLER, F.R.S.

The paper includes a catalogue of more than 300 lines attributed to O III of which about one-half have been classified by the author and others. As was expected, the spectrum is generally similar to that of N II, and the terms so far determined are in complete agreement with Hund's theory.

The assigned term values are based upon a sequence of three singlet D terms. The deepest term of the type $^3P_0$, and for this the value 444661 has been determined by adopting Bowen's suggestion that the well-known green lines, λ 5006.8, λ 4958.9, in the spectra of gaseous nebulas are due to irregular combinations of deep terms of O III. The corresponding ionisation potential of O III is 54.88 volts.

The Spectrum of Fluorine (FI). By H. DINGLE. Communicated by A. Fowler, F.R.S.

The spectrum FI has been investigated in the region λ 7600-λ 8400, and the wavedengths of 16 lines have been measured.

The analysis of the spectrum previously made has been slightly modified and extended, and an approximate ionisation potential of 18.6 volts calculated.

Relative term values of FI, based on the two metastable states of the core, have been deduced.

The Crystal Structure of the Chondrodite Series. By W. H. TAYLOR AND J. WEST. Communicated by W. L. Bragg, F.R.S.

Chondrodite, Humite and Clinohumite have been examined by the rotating crystal method and by the ionisation spectrometer. Humite is based on a simple orthorhombic lattice, space group V_h^{16}, the unit cell containing four molecules. Chondrodite and Clinhumite are each based on a simple monoclinic lattice, space group C_{2h}^5 the unit cell containing two molecules. In the absence of quantitative study, no claim to great accuracy is made in the values given to the numerous parameters involved, but, in view of the excellent qualitative agreement for the numerous planes examined, it is not likely that there is much distortion from the structures given.

The crystals bear a strong crystallographic resemblance to each other and to olivine, and have long been interesting as an example of morphotropy. Their mutual relations are discussed, with the help of the structures suggested. The latter are all based on a hexagonal close-packed arrangement (somewhat expanded) of O atoms and OH groups, amongst which are distributed Mg and Si atoms, in such a way that whilst Mg atoms lie within groups of 6 atoms (O or OH) each Si atom is surrounded by 4 atoms. The Mg_2SiO_4 portion of each crystal possess the olivine structure.

All three structures may in effect be regarded as built up of alternate layers (parrallel to the *c* face) of $Mg(OH)_2$ and olivine. The cementing layer of $Mg(OH)_2$ has the same thickness in all, whereas the thickness of the olivine layer differs for each the ratio of the thicknesses being that of the $MgSiO_3$ content of each molecule.

RIGIDITY AND OTHER ANOMALIES IN COLLOIDAL SOLUTIONS.

By EMIL HATSCHEK, F.Inst.P.,
Lecturer on Colloids, Sir John Cass Technical Institute.

(Before the Royal Institution of Great Britain.)

ABSTRACT.

As the term "rigidity" has colloquial and metaphorical connotations it may be advistble to begin by defining the strict technical meaning of the term. If we consider a cube of an elastic solid fixed with two opposite faces to two parallel planes, one of which is immovable, while a tangential force is applied to the other, the cube undergoes a deformation which is called "shear." It resists it by virtue of a property called its "rigidity," which causes it to return to its original shape, as soon as the force or stress ceases to act.

Rigidity is one of the most characteristic properties of the solid state, and absent in all normal liquids. We can best realise the difference between solids and liquids in this respect by considering what is now merely an ideal case: two indefinitely extended parallel planes, between which a liquid is contained. If now a force, however small, is applied to one plane, while the other is kept fixed, it moves, not only a small distance as with the elastic solid, but continu-

ously as long as the force acts, and comes to rest as soon as it ceases to do so. The force required to maintain a certain velocity is proportional to the area of the plates, the velocity gradient, *i.e.*, the velocity of the moving plate divided by its distance from the fixed one, and depends on a property of the liquid called its viscosity. A quantitative expression again suggests itself from the conditions of this mental experiment: the force per unit area required to maintain unit velocity when the plates are unit distance apart; this is called the viscosity coefficient. In all liquids it decreases rapidly with rising temperature.

A very remarkable feature of this physical constant is that in all normal liquids it is *quite independent of the velocity with which they are being sheared: if all else is kept* constant, the forces required to maintain two different velocities are exactly proportional *to these velocities*. The *proof of this* constancy of the viscosity coefficient is both indirect and direct. The mathematical *theory, e.g.*, that of the *measuring devices*, has been developed on the assumption of a constant viscosity coefficient, and the results agree with experiment. The viscosity of water has been measured by a number of observers over a range of velocity gradient varying in the ratio of 1 to 10,000 and has been found quite constant.

The arrangement of two parallel planes with liquid between them, which we have been considering, is hardly realisable experimentally, but we can, without materially affecting the reasoning, so to speak, roll up the two planes, and confine the liquid between two concentric cylinders, the outer of which is rotated while the inner is at rest. This arrangement, to which we shall refer again, can then be used for determining viscosities over a great range of velocity gradients.

Historically this is not the first device used for such measurements. The systematic study of viscosity began with the work of Poiseuille, who, in 1842, found empirically the law governing the flow of liquid through a capillary tube. This "*transpiration* method," as it was originally called, has been very largely used since for determining the *viscosity coefficients of all kinds* of liquids. Thomas Graham, the founder of colloid chemistry, applied it to colloidal *solutions*, and was greatly struck by the changes in viscosity which they exhibited on ageing, or on addition of electrolytes, so that in his famous paper of 1863 on Silicic Acid he made the often quoted remark that "a liquid transpiration tube may be employed as a colloidoscope."

I published early in 1911 a theoretical paper in which the behaviour of a system having the constitution which was then ascribed to colloidal solutions was investigated. The conclusion reached was that such a system would have a variable viscosity which should become constant above a certain velocity gradient. I then proceeded to test these conclusions experimentally, not in the capillary viscometer, which, from this point of view, is theoretically useless, but in a modification of the concentric cylinder apparatus first used by Couette in 1890.

The suggestion that solutions which nobody would hesitate to describe as liquids *should possess one of the fundamental properties* of solids is so surprising, that one is naturally anxious to have a direct demonstration *rather than a mere inference from* mathematical treatment. There is no difficulty in providing this demonstration with suitable apparatus—delicate and unsuitable for lecture experiments—which will be described later. I have, however, been fortunate enough to discover a solution which exhibits rigidity on such a scale that it can be demonstrated with extremely simple means in a most convincing manner. This liquid is a very dilute, about one-quarter per cent., solution of ammonium oleate, a soap familiar to this Institution as material for soap bubbles. Its rigidity can at once be shown in this simple apparatus. A cylinder, weighted at the bottom and centred in a footstep, is suspended free in the solution. If a spin is given to the cylinder it will, in a normal liquid revolve till the momentum is used up and then simply come to rest. The rigid ammonium oleate, however, behaves somewhat as would a hollow cylinder of rubber: the cylinder comes to rest, but is then pulled backwards.

As the ammonium oleate exhibited such *striking rigidity, it* seemed to us an excellent means of testing the connection between rigidity and variable viscosity. We found *that it exhibited another striking anomaly*, which can be described only by the statement, extravagant as it sounds, that the *solution has no definite viscosity at all*. It changes constantly, and as we have shown, periodically, during a long period of measurement.

This anomaly is fortunately unique. As regards rigidity, no other solution which has yet been examined shows this effect so strikingly, and to demonstrate rigidity, and

especially to make actual measurements of the modulus, much more delicate means have to be employed. Schwedoff, in pursung the line of investigation by Kundt, developed a method and constructed an elegant apparatus, with which he carried out—or at any rate published—a single determination, that of the modulus of a 0.5 per cent. gelatin solution, in 1889. About 18 years later, Rohloff and Shinjo, at Gottingen, investigated the rigidity of gelatin solutions by a different method, and over an extensive range of concentrations, ages and temperatures.

We thus have considerable direct evidence of the existence of rigidity in the solutions which exhibit anomalous viscosity, and measurements of the latter over a very wide range, as well as the moduli of a number of them. As regards the causes of these anomalies we are still in the dark, although there has been no lack of *ad hoc* hypotheses. The characteristic of colloidal solutions is that the dissolved substance is not split up into molecules like, *e.g.*, cane sugar in water, but into particles or aggregates containing many atoms or molecules, though still invisible in the microscope. In a number of colloids these particles can be made visible in the ultra-microscope, but the majority of those we have investigated show no particles even there. To explain the anomalies it has been suggested that the particles have peculiar shapes, and that they form threads or filaments, ramifying structures, etc. Although they are much larger than molecules they are yet supposed to be modelled on the shape of the molecule, such as the long-chain molecules of the fatty acid salts, or the long chains of amino-acids which form proteins like gelatin. As mentioned, there is little or no direct evidence of such structures, and the extreme chemical and constitutional diversity of the substances whose solutions show anomalies makes the explanation improbable or inadequate. To mention one case only: ammonium oleate no doubt has a long-chain molecule, but the mercury-snlphosalicylic acid is a simple aromatic compound.

It is, however, not only the extreme diversity of molecular structures which makes such attempts at explanation unconvincing, but we have experimental evidence showing beyond any doubt that variable viscosity can be produeed simply by suspending in a normal liquid a small volume percentage of microscopic particles of nearly spherical shape. I showed in 1916 with Dr. Edith Humphrey that such suspensions (rice starch in an indifferent organic liquid of the same density exhibited viscosities which varied with the velocity gradient exactly as do the viscosities of colloidal solutions. The measurements were repeated and extended last year.

There is no evidence, and certainly no probability, that these microscopic particles aggregate in any way into filaments or the like, and there is thus no possibility of ascribing the variable viscosity in this case to any special configuration or arrangement. Its cause must therefore be looked for in some effect which they produce on the surrounding liquid. There is a very large amount of evidence drawn from the most diverse phenomena to show that particles n a liquid are altered, so that the virtual volume of the particles is increased and that of the liquid reduced. The measurements on suspensions prove that these layers must extend further into the liquid than would appear from some other evidence, and that they must be labile enough to be affected by the shearing of the liquid. These considerations apply to all particles, whatever their shape or arrangement, though the latter factors naturally add to the complications of the effect.

It would be tempting to speculate on the significance of the anomalies which have been discussed in regard to processes in organisms, all of which consist largely of colloidal material. I do not propose to do so, but to conclude by drawing attention to the general physical aspect of variable viscosity and rigidity in colloidal solutions. It is known that under enormous pressures solids behave like liquids, *i.e.*, flow; colloidal solutions exhibit the converse behaviour: under exiguous stresses they approximate the behaviour of solids by exhibiting enormous viscosities. Many of them pass continuously into jellies, which, as shown at the beginning, behave within limits like elastic solids, and these steady transitions recall the maxim—which it is perhaps somewhat daring to recall in these days of quanta—that "Natura non agit per saltum."

GERMAN MATCH INDUSTRY.

Over 70 per cent. of the match industry is controlled by the Swedish Match Trust. As the total annual production of the German factories is about 350,000 csaes, and inland consumption 190,000 cases per annum, the industry is suffering from over-prodnction,

International Trade Conditions

It is always interesting to read and study the Trade and Financial Conditions of other countries, especially as the welfare of all civilised nations are more or less interdependent on each other. The Royal Bank of Canada recently published some interesting facts on the above subject.

In 1910, a large proportion of the commerce of the world was the result of an exchange of the finished products of the highly industrialised countries, for the raw or partially manufactured goods of the rest of the world. Particularly in Western Europe this trade relationship had permitted the growth of large, thickly populated manufacturing centres. In the chaos which followed 1914, each nation was thrown upon its own resources and even those countries which took no active part in the war found themselves cut off from their ordinary markets and sources of supply. The growth of manufacturing which followed stimulated the idea that each country might become more wealthy if it should become more economically independent. This idea ,together with the creation of new international boundaries and the growth of a strong feeling of nationalism amounting in some cases to bitter animosity against neighbouring states, resulted in the erection of new trade barriers and a general raising of tariffs.

The most densely populated sections of the world are China, Japan, India and Western Europe. In China, Japan and India the population is accustomed to a low standard of living. Yet, even in these countries, readjustment is under way. China and India are beginning to manufacture their own textiles and a major revolution is taking place in Japan. As far as Europe is concerned, however, the most portentous development is the growing variety and importance of the manufacturing industries in such countries as Canada, Australia, Brazil and Argentina.

It is this world readjustment which is making difficult the problems of rehabilitation in Western Europe. Internal political problems, traditions and the opposition of labour towards measures which make for efficiency, increase the complexity of this situation.

The standard of living in almost every country of Europe is below that of 1913; unemployment is prevalent and there are those who think that the outcome of the present economic changes will be a substantial and permanent lowering of the European standard of living. When one considers the energy and ability of the people and the history of their achievement in creating modern industrial civilisation, this hypothesis does not seem probable. Since birth rates are falling and the population of a number of European countries is ebecoming fairly constant though not actually decreasing, there is some thought that assisted by emigraton, a readjustment in population may take place which will leave such countries as Germany, Belgium, Holland and Great Britain with a population more nearly proportionate to the natural resources of these countries.

Actually, the turn of post-war events seems to foreshadow an outcome which will entertain a combination of these proposals. Undoubtedly, wide-spread unemployment and reduced appropriations for education have been significant of at least a temporarily lowered standard of living. A nearly static volume of population in a number of European countries might simplify readjustment. It is quite evident that there is a tendency for the higher standard of living in Europe to spread to other parts of the world.

For Canada, the outcome is not fraught with the same grave significance as for Western Europe and Great Britain, but a solution which involved a general rise in the standard of living in all parts of the world, creating a rapidly increasing demand for agricultural, mineral and forest products would be of great benefit to this country.

Great Britain.

With the normal growth of population and with rising standards of living in most parts of the world, it is natural to anticipate an annual growth in the volume of production of all important industries, and a corresponding increase in the volume of world trade. Within the last two years, most European countries have made good the actual losses in volume of manufacturing and commerce due to the war, and for 1927, in many cases, a slightly favourable comparison may be made between present levels and those which existed in 1913. From this viewpoint, the analysis of the production figures of the basic industries of Great Britain is disappointing. It is doubt-

ful whether coal mining, the manufacture of iron and steel, and shipbuilding have yet attained a volume 90 per cent. as large as that of 1913, and the tonnage of foreign commerce is not more than 60 per cent. as large as before the war. Recovery in Great Britain has been more seriously retarded than in any other important country.

The coal industry is still suffering from the fact that the stoppage in British production in 1926 stimulated production in continental countries and the recapture of many foreign markets can only be accomplished at the cost of substantial price concessions. It is doubtful whether the reorganisation in the mines has been sufficiently drastic to put them in a competitive position in the international market.

FRANCE.

The internal balance of production and consumption is much more satisfactory in France than in Great Britain. To no small extent this is due to a satisfactory proportion betewen agricultural and industrial producers. Moreover, the large number of workers employed in the manufacture of specialties and luxuries constitutes a producing group who are not working in direct competition with workers in most other manufacturing countries, and foreign demand for this class of goods is sufficient to permit profitable exportation in spite of high tariff barriers.

Since a large proportion of the credit necessary for the rehabilitation of the devastated regions has been created within the country, France has not needed to make as large external loans as were at first anticipated. This has been a remarkable achievement. In reality, the value of the capital goods created through the rebuilding of French industry along more modern lines is a feat that has not received full recognition in the outside world.

GERMANY.

Since the beginning of 1926, unemployment which had then reached the two million mark, decreased until by October 1, 1927, it amounted to only 355,000. Industry and trade are extremely active; iron and steel production, for instance, during the last quarter exceeded the production of the same quarter of 1925 by 40 per cent. The volume of foreign trade during the last three months exceeded that of 1925 by 28 per cent., but the unfavourable balance of merchandise trade remains heavy, and for the quarter mentioned it amounted to 659 million marks. So long as foreign capital is invested in Germany at a more rapid rate than Germany makes reparation payments, merchandise imports are likely to exceed merchandise exports. The most satisfactory comment which may be made concerning these imports is that they have largely consisted of raw materials for manufacture and are thus a further indication of the activity of industry. A return to normal industrial activity must be particularly welcome in a country which has experienced the industrial and commercial depression and upheaval which Germany has gone through in the last ten years.

BUSINESS CONDITIONS IN THE UNITED STATES IN 1927.

No factor in the United States business situation has brought forth more general comment than the prolonged upward trend of the average price of the securties listed on the New York Stock Exchange. In the past, rising security prices have been so persistently associated with prosperity that it is difficult for the financial observer to make any other association. Yet, production records, car loadings and the general trend of the basis statistics of industrial activity in the United States have not been particularly favourable during the past few months. For an explanation of the movement of security prices ,we must look to the ease of credit and to the readjustment of values which have been out of line ever since 1914. In a country with a growing population and with a rising standard of living, new weekly or monthly records of industrial production are normal and failure to surpass previous records constitutes minor reaction.

In a country where credit is on the easy and flexible basis which now exists in the United States, where the excellent crops of 1927 ensure relative agricultural prosperity, where industry is sufficiently efficient to maintain a large export trade, where the buying power of labour and agriculture is at a level which will make probable a good volume of internal trade and where inventories are in most cases so low as to demand iimediate replenishment, curtailment cannot be more than temporary.

IMPROVED INDUSTRIAL PROSPERITY.

MORE PATENTS IN 1927.

It is very satisfactory to note that there has been an increase of over 2,000 Patent Applications this year beyond those of 1926 and that it is the best year since 1922.

Messrs. Rayner & Co., the well-known London Patent Agents also informs us that

Electrical inventions are largely in evidence due no doubt to the Government scheme of electrification of the country. In this section, also, Telephonic Research has been *given a great impetus owing to the further* adoption by the G.P.O. of the Automatic Telephone.

Chemistry runs into second place, many applications coming from Germany relating to dyes and colours. Synthetic Silk, the wonder-child of the Chemist, is being very largely experimented with by great English and foreign concerns, who have obtained numerous patents. "Wireless," however, has not been so brisk as in the last two or three years, though the results are still exceptionally good for such a youthful industry.

The rest of our great industries, including especially the Motor trade, are well represented in the general trade advance of the *arts and crafts*. The improved Patent Office figures will greatly brighten the outlook for business in the coming year.

FORTHCOMING EVENTS.

GEOLOGICAL SOCIETY.

Burlington House, London, W.1.

Tuesday, January 10, at 5.30 p.m.

The next meeting of the Society will be held on Wednesday, January 11, at 5.30 p.m., when the following communication will be read :—

"The Geology of South-Eastern Arabia," by George Martin Lees, M.C., D.F.C., F.G.S.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, Victoria Embankment, London.

Wireless Section.—Monday, January 9, at 7 p.m.—"*Portable Power Appliances.*" Dscussion to be opened by A. E. Loe.

Mersey and North Wales (Liverpool) Section.—Monday, January 9, at 7 p.m., at the Laboratories of Applied Chemistry, Liverpool University.—"Technical Principles of Broadcasting," by Capt. P. P. Eckersley.

North Midland Centre, at the Hotel Metropole, Leeds.—Tuesday, January 10, at *7.15 p.m.*—"The Problem of Public Lighting by Electricity," by H. T. Harrison.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

At the Rooms of the Royal Society of Arts, John Street, Adelphi, London.—Tuesday, January 10, at 5.30 p.m.

INSTITUTION OF MINING ENGINEERS.

The 38th Annual Meeting will be held in the Rooms of the Geological Society, Burlington House, London, W.1., on Tuesday, January 10, at 11 a.m. The following papers will be submitted for discussion :—

(1) "The Rhéolaveur Coal-washer in Belgium." By Prof. Henry Briggs, D.Sc. Ph.D., and Prof. Henry Louis, M.A., D.Sc.

(2) "The Use of a Lamp-room Photometer." By Dr. J. S. Haldane and Dr. R. V. Wheeler. A demonstration of the Photometer will follow the reading of the paper.

(3) "Life-saving in Colliery Explosions and Fires." By T. A. Southern.

(4) "The Measurement of Low Air-velocities in Mines." By J. P. Rees, B.Sc.

A party, limited to 50, are to visit Snowdon Colliery, Kent, on Wednesday, January 11.

INSTITUTE OF METALS.

Scottish Local Section.—Monday, January 9, *at 7.30 p.m., Room of the Institution* of Engineers.—Open Discussion.

N.E. Coast Local Section.—Tuesday, January 10, at 7.30 p.m., Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne.—"Permanent Mould Casting in Aluminium Alloys," by George Mortimer.

London Local Section, at the Room of the Society of Motor Manufacturers and Traders Ltd., 83, Pall Mall, London, S.W.1.—Thursday, January 12, at 7.30 p.m.—"Segregation in Metals and Alloys," by S. W. Smith, D.S., F.I.C.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

36, George Street, Manchester.

Tuesday, January 10.—Council Meeting.

OIL AND COLOUR CHEMISTS' ASSOCIATION.

At the National Federation of Paint Manufacturers, 8, St. Martin's Place, Trafalgar Square, London.—Wednesday, January 12.—"Some Points on the Manufacture of Zinc Oxide," by R. G. Daniels, B.Sc., A.I.C.

OPTICAL SOCIETY.

Joint Exhibition with the Physical Society.

PHYSICAL SOCIETY.

Imperial College of Scence, South Kensington, London.

Tuesday, Wednesday and Thursday, January 10, 11 and 12. Afternoon and Evening.—Annual Exhibition.

ROYAL SOCIETY OF ARTS.

John Street Adelphi, London.

Wednesday, January 11, at 3 p.m.—Dr. Mann Juvenile Lecture: "Flame." *Lecture 2, by Prof. Arthur Smithells, C.M.G.*

SOCIETY OF PUBLIC ANALYSTS.

At the Institute of Chemistry, 30, Russell Square, London.

Wednesday, January 11, at 8 p.m.—The following papers will be read:—"The Determination of Small Quantities of Benzoic and Cinnamic Acids, with some Notes on the Colorimetric Determination of Salicylic Acid." By J. R. Nicholls, B.Sc., F.I.C. "A Rapid Method of Determining Sulphur Dioxide," and four additional papers, by the Preservatives Determination Committee of the Chemists of the Manufacturing Confectioners' Alliance, Food Manufacturers' Federation.

ROYAL INSTITUTION.

21, Albemarle Street, London, W.1.

Tuesday, January 10, at 3 p.m.—"Engines," by Edward N. da C. Andrade, D.Sc., Ph.D., M.R.I. VI Christmas Lecture.

NOTICES OF BOOKS.

Photochimie. Par A. BERTHOUD. Pp. 332. 1928. Price 40 francs. Gaston Doin & Cie, 8, Place de l'Odéon, Paris.

Malgré le remarquable développement que la photochimie a pris depuis un certain nombre d'années, il n'existait jusqu-ici, en langue française, aucun ouvrage de caractère général sur ce sujet. Le livre de M. Berthoud vient combler cette lacune de notre bibliographie chimique.

L'auteur ne s'est pas proposé une étude systématique de toutes les réactions sensibles à la lumière. Il s'est attaché surtout à donnerl un tableau précis de l'état de nos connaissances concernant les lois des phénomènes photochimiques, les facteurs dont ils dépendent et les théories explicatives.

Dans la première partie de l'ouvrage, on trouvera un bref résumé des notions essentielles relatives à l'énergie rayonnante et spécialment des lois et de la théorie de l'absorption et de l'émission de la lumière, ainsi qu'un aperçu des phénomènes de fluorescence et de phosphorescence.

L'étude des réactions photochimiques forme la seconde partie qui est de beaucoup la plus étendue. Pour donner une idée aussi claire que possible de nos connaissances actuelles et en faire en quelque sorte une synthèse, les données expérimentales *ont été groupées en une série de chapitres* consacrés chacun à une question spéciale: *loi de l'equivalence, sensibilisation, action* de la lumière polarisée, phototropie, hypothèse radiochimique, etc. Les deux derniers chapitres se rapportent à l'assimilation chlorophyllienne et à la photographie considérée surtout du point de vue des réactions qui se produisent dans la plaque sensible.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

33,831.—Croad, A. K.—Securing electrical contact with crystalline cuprous oxide. December 14th.

33,683.—Ellis, G. H.—Mannfacture of dyestuffs. December 13th.

33,707.—I. G. Farbenindustrie Akt.-Ges. —*Manufacture of solutions for dyeing.* December 13th.

33,657.—Woodward, W. E.—Rendering porous materials resistant to chemicals. December 13th.

Specifications Published.

281,827.—Haworth, W. N., and Nelson, Ltd., J.—Method of concentrating aqueous solutions of acetic or formic acid.

281,795.—British Dyestuffs Corporation, Ltd., Payman, J. B., and Wignall, H.—Manufacture of new derivatives of 2 : 3-hydroxynaphthoic arylides.

Abstract Published.

279,790.—Thiuramdisulphides. — Silesia Verein Chemischer Fabriken, Inda- und Marienhutte, near Saarau, Germany.

Thiuramdisulphides are prepared by the oxidation of alkyl-aryl-substituted dithiocarbamic acids in alkaline solution by means of a mixture of nitric oxide and air. In an example dimethyldiphenylthiuramdisulphide is prepared by passing a stream of nitric oxide and air into an alkaline solution of the ammonium alkali salt of methylphenyldithiocarbamic acid.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

TESTACOIDS.

477,816.—Chemical substances prepared for use in medicine and pharmacy.—Reed & Carnrick, 155 to 159, Van Wagenen Avenue, Jersey City, State of New Jersey, United States of America. December 21st.

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CONTENTS. PAGE.

Structure Symbols 17
By Ingo W. D. Hackh, College of Physicians and Surgeons, San Francisco, U.S.A.
Density and Electrical Properties of the System Rubber-Sulphur 22
By H. L. Curtis, A. T. McPherson,, and A. H. Scott.
Absorption Spectra of Iron, Cobalt, and Nickel 23
By W. F. Meggers, and F. M. Walters, Jr., U.S.A. Bureau of Standards.
General Notes :—
Some Impotant Uses of Carbon Dioxide 25
Canada's Record Mineral Output ... 25
Ten Million Colliery Scheme 26
Institution of Mining Engineers ... 27
Proceedings & Notices of Societies :
Society of Glass Technology 27
Reviews of Books 29
Forthcoming Events 30
New Patents 31
New Trade Marks 32

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A course of 5 lectures and practical work intended for analysts and others. It is also suitable as a revision class in electrochemistry for Students preparing for the examinations of the Institute of Chemistry and London University.

THURSDAYS, FROM 7 TO 9 P.M., COMMENCING JANUARY 12, 1928.

ENGLISH LAW AS RELATED TO INDUSTRIAL CHEMISTRY.

By G. S. W. MARLOW, B.Sc., F.I.C.

This course will consist of eight lectures and will deal with the subject from the point of view of the Student and Industrial Chemist who aspires to a responsible administrative appointment. The various Acts of Parliament which affect Chemical, Metallurgical and Associated Industries will be dealt with, and the responsibilities thrown by Law on those holding managerial positions will be pointed out.

TUESDAY EVENINGS, FROM 7 TO 8 P.M. COMMENCING JANUARY 24, 1928.

Details of the above courses may be had upon application to the Principal.

STRUCTURE SYMBOLS.

By INGO W. D. HACKH.
(College of Physicians and Surgeons, San Francisco, U.S.A.)

The idea to give to each organic compound its own distinct symbol, seems preposterous and impractical, for the number of such symbols would far surpass the number of Chinese Characters. Yet by the simple assumption of the valencies of

hydrogen.......one bond
oxygen..........two bonds
nitrogen.........three or five bonds
carbon...........four bonds

it is possible to ascribe a distinct symbol to every organic compound. Each of these symbols represents on a plane surface the

internal arrangement of the atoms within a molecule. No matter what our concepts as to the nature of these "bonds" might be, whether they are non-polar bonds caused by the sharing of a pair of valence electrons, —*or polar bonds, caused by the actual transfer* of a valence electron the concept of valence and molecular structure has stood the test of experience.

A structure symbol is a valence skeleton *showing only the bonds, but not the ordinary* symbols for H, C. N, and O. In these symbols a point from which one line radiates is supposed t orepresent an atom of hydrogen, Two lines coming together represent oxygen, THREE or FIVE lines meeting indicates an atom of nitrogen, and FOUR lines an atom of carbon. Thus we have—

```
                                        H
          H        H                    |
H—H        >O       >N—H        H—C—H
          H        H                    |
                                        H

 —         >        >—            +
```

as the structure symbols for hydrogen gas, water, ammonia and methane.

The distinct advantages of structure symbols over the ordinary structural formulæ or skeleton formulæ are :

1. Compactness, for the structure has *been reduced to a very narrow compass.* In an earlier paper it has been shown that the structural symbols took less than four-tenths the space required for printing the names of the compounds*.

2. Exactness, for the symbols represent only ONE definite compound or one distinct isomeric form.

3. Accuracy, for it is impossible to write for a given compound a structure symbol which is not theoretically correct, provided the simple rule regarding the valencies is followed.

4. Clearness, for the design of the symbols of certain types of compounds is distinct and helps one to memorise the characteristic groups, radicals or compounds.

5. Simplicity, for with a very few rules the thousands of structure symbols can be constructed and their meaning understood.

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* Some Constituents of Essential Oils and their Structural Relations, *Journ. Am. Pharm. Assoc*, 1920, ix, 948.

In general it is found that a structure symbol represents more information than the ordinary structure formula in which some of the carbon or hydrogen atoms are left out, leaving it to the reader to supple*ment the missing ones. In the class-room* it has became a valuable aid, for by its means it is possible to convey more structural facts than would be possible otherwise.

To insure uniformity and neatness of appearance of the symbol it is advisable to follow a few rules :

ASYMMETRIC atoms are indicated by a dot at the junction of the lines. (Compare lactic acid in the table of acids.)

HETEROCYCLIC atoms are indicated or rather accentuated by a dot placed outside the lines. (Compare heterocyclic compounds in the table of hydrocarbons.

ELEMENTS other than C, H, O, and N, are indicated by their ordinary symbol. (Compare sulphur compounds in section 6 and arsenides, halides in table.)

Single bonds are straight lines and if possible of equal length; double bonds are curved lines; ring compounds are geometrical figures, thus if the ring contains five atoms—a pentagon; six atoms—a hexagon.

The accompanying illustrations show a systematic list of some organic compounds and the radicals derived therefrom, the radicals.

(*See Pages* 19-21.)

BOARD OF TRADE ANNOUNCEMENT.

DYESTUFFS (IMPORT REGULATION) ACT, 1920.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during December, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

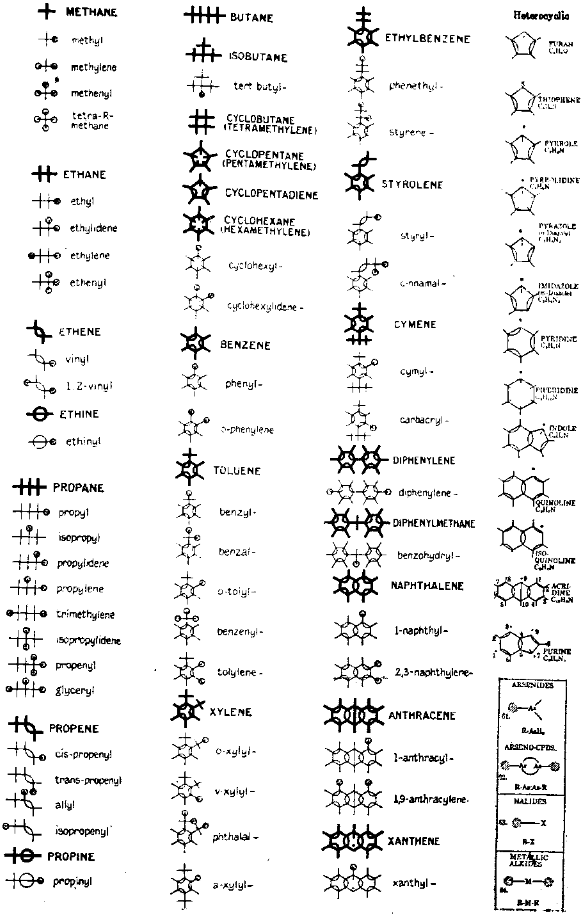
The total number of applications received during the month was 511, of which 431 were from merchants or importers. To these should be added 30 cases outstanding on the 30 November, making a total for the month of 541. These were dealt with as follows :—

Granted—485 (of which 450 were dealt with within 7 days of receipt).

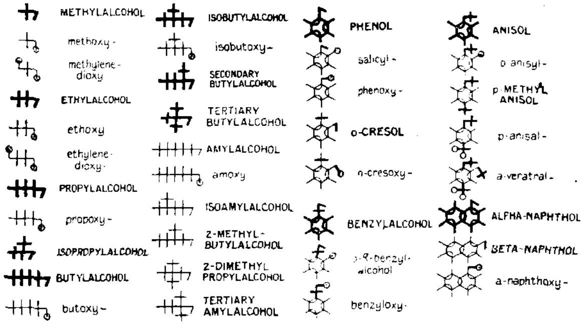
Referred to British Makers of similar products—39 (of which 30 were dealt with within 7 days of receipt).

Outstanding on 31 December—17.

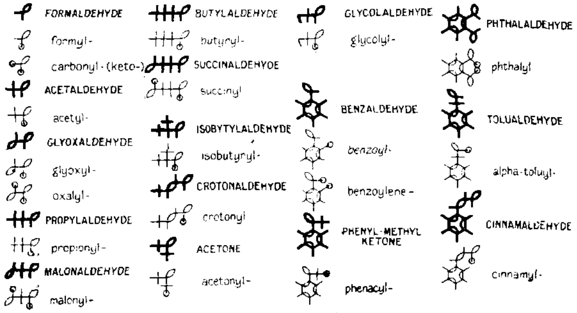
Of the total of 541 applications received, 480, or 89 per cent., were dealt with within 7 days of receipt.



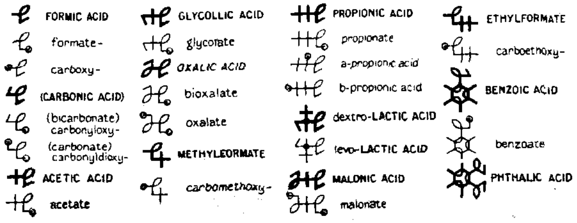
(1) Hydrocarbons.



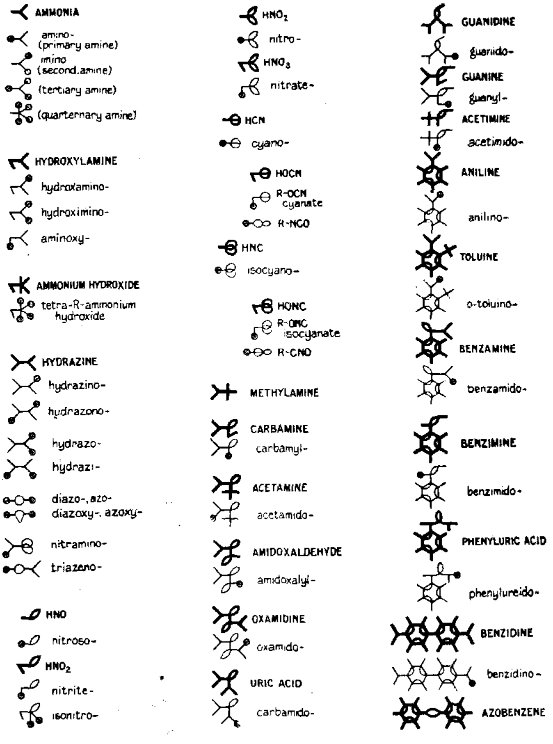
(2) ALCOHOLS, ETHERS AND PHENOLS.



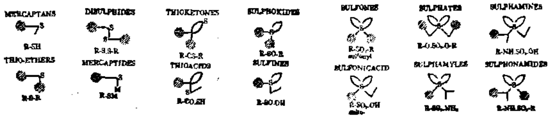
(3) ALDEHYDES AND KETONES.



(4) ACIDS AND ESTERS.



(5) NITROGEN COMPOUNDS.



DENSITY AND ELECTRICAL PROPERTIES OF THE SYSTEM, RUBBER-SULPHUR.

By *H. L. Curtis, A. T. McPherson* and A. H. Scott.

Density and electrical properties of compounds of rubber and sulphur were measured for the range of composition from 0 to 32 per cent. of sulphur, or from crude rubber to hard rubber. Important changes in the properties with the proportion of sulphur were noted. These changes show definite regularities and occur at compositions which may be represented by simple empirical formulas; they are, accordingly, taken as indicating the existence of definite compounds of rubber and sulphur.

At the composition 19 per cent. of sulphur, which corresponds to $(C_5H_8)_2S$, all the properties which have been studied undergo significant changes. At this composition the curve relating density to percentage of snlphur shows a change in slope, and the curve relating thermal expansivity to percentage of sulphur, a distinct inflection. Both the dielectric constant and the power factor curves pass through minima at 19 per cent. of sulphur, while the resistivity curve takes a decided upward trend.

The composition 10.5 per cent. of sulphur, which corresponds to the formula $(C_5H_8)_4S$, is marked by a maximum value of the dielectric constant. The power factor shows a maximum at 13.5 per cent., which may represent $(C_5H_8)_3S$, or else an equimolecular mixture of $(C_5H_8)_2S$ and $(C_5H_8)_4S$. The maximum of the resistivity occurs at about 26 per cent. of sulphur, which corresponds to $(C_5H_8)_4S_3$. Other properties show changes of a less marked nature at these compositions.

No extensive study was made of the effect of free sulphur on the electrical properties of rubber, but data were obtained which indicate that it is small relative to the effect of combined sulphur.

Dielectric strength measurements are not reported because the values seem to depend more on the conditions of test than on the properties of the compounds.

A substantial increase in density accompanies the vulcanisation of rubber with sulphur. The volume change is due to chemical reaction between rubber and sulphur. The density of a compound of rubber and sulphur, is, therefore, a function of its composition. The density is independent of the means used to effect combination of rubber and sulphur, except that long heating after the reaction is practically complete causes a slight increase in density which is apparently due to secondary reactions.

The relation between density and composition may be represented approximately by a linear curve with a discontinuity in slope at 19 per cent. of sulphur, the composition which corresponds to half the maximum proportion of sulphur with which rubber can combine.

The volume change accompanying the vulcanisation of rubber-sulphur mixtures increases with increasing proportion of sulphur up to 19 per cent. From this composition to 32 per cent. the volume change is approximately constant.

The density changes which occur during the vulcanisation of a given stock are not simple; one complicating factor is the transformation of the sulphur to allotropic modifications of different density. In general, the density change on vulcanisation of a stock containing 19 per cent. of sulphur bears a linear relation to the proportion of combined sulphur; with time of cure, the density increases rapidly at first, then more slowly, and ultimately makes an asymptotic approach to a constant value.

The coefficient of thermal expansion of rubber-sulphur compounds decreases with increasing sulphur content, but not in a linear manner.

SOME ELECTRICAL PROPERTIES OF RUBBER-SULPHUR COMPOUNDS.

By H. L. Curtis, A. T. McPherson, and A. H. Scott.

This paper represents a systematic study of the effect of vulcanisation on the electrical properties of rubber. Dielectric constant, power factor, and resistivity were measured over the entire range of compositien in which rubber may combine with sulphur. The electrical properties show regularities which suggest the existence of several definite chemical compounds of rubber and sulphur.

The published data on the electrical properties of rubber-sulphur compounds relate in general to ranges of composition between 2 and 10 per cent., and between 25 and 32 per cent. of sulphur, the former being associated with soft rubber and the latter with hard rubber. Moreover, in many cases data on the electrical properties of rubber are cited in which the effect of vulcanisation with sulphur is not differentiated from the effect of adding other constituents. In a previous investigation, however, it was noted that the dielectric constant and power

factor of soft rubber increased with the per cent. of sulphur and reached values which were decidedly higher than those ordinarily assigned to hard rubber. This indicated that these properties must have maximum values in the region of composition between soft and hard rubber. The results herein reported show that as the percentage of sulphur is increased beyond that used in the vulcanisation of soft rubber, both the dielectric constant and the power factor pass *through maxima, and then, with still more* sulphur, pass through minima before the hard-rubber stage is reached.

When several different properties have a maximum or a minimum value at the same point in the composition curve, the existence of a definite chemical compound is indicated. On this basis the electrical properties indicate that the following compounds exist :— $(C_5H_8)_4S$, $(C_5H_8)_2S$, $(C_5H_8)_4S_3$, and possibly $(C_5H_8)_3S$.

CONCLUSIONS.

The electrical properties of rubber-sulphur compounds depend primarily upon the percentage of sulphur in combination with the rubber. Free sulphur has a relatively small *effect on the electrical properties.*

As the combined sulphur in vulcanised rubber is increased from 0 to 32 per cent. the electrical properties show the following changes :

The dielectric constant increases until a *maximum value is reached at 10.15 per* cent. of combined sulphur, decreases to 19 per cent. and then increases slightly from this composition to 32 per cent.

The power factor behaves similarly, except that the maximum value comes at 13 per cent. of combined sulphur.

The resistivity increases up to a maximum at 26 per cent. and decreases from this point to 32 per cent. of combined sulphur. The curve shows reasonably distinct changes in direction at approximately 10.5, 13.5, and 19 per cent. of combined sulphur.

The electrical breakdown is affected to such an extent by the circumstances of test that no reliable conclusions can be drawn from present data as to the effect of varying sulphur content in this property.

It is noteworthy that all of these changes, as well as changes in the density relations, occur at compositions which may be represented by *simple formulas. The existence* of a definite compound of empirical formnla $(C_5H_8)_2S$ is indicated by all of the properties which have been studied. The evidence for three other compounds $(C_5H_8)_4S$, $(C_5H_8)_3S$, and $(C_5H_8)_4S_3$ is less complete. The idea of the formation of definite compounds in the reaction of sulphur with rubber is in accord with well-established principles of organic chemistry.

ABSORPTION SPECTRA OF IRON, COBALT AND NICKEL.

By W. F. MEGGERS AND F. M. WALTERS, JR.
(Scientific Paper, U.S.A. Bureau of Standards.)

The underwater spark absorption spectra, as well as the ordinary vapour absorptions, have been investigated by others, but not in sufficient detail in connection with the spectral structures of Fe, Co, and Ni. Employing high potential condensed sparks between electrodes of iron, cobalt, and nickel immersed in water, the underwater spark spectra of these metals were re-examined *throughout the visible and ultra*violet regions. The spectrograms show 265 iron lines (2166 to 4404 A), 340 cobalt lines (2137 to 4121 A), and 225 nickel lines (2124 to 3858 A) absorbed in the source. In each case the majority of these are identical with the stronger lines of the arc-emission spectra, and practically all such lines are found to involve either the normal state or some low metastable state of the neutral atoms. *These results confirm and extend the known* spectral structures for neutral Fe, Co, and Ni; the normal states of these atoms are represented by ^5D, ^4F, and ^3F terms, respectively. The type of source used showed most of the metallic spark lines in emission, but certain groups were present in absorption with low intensity. The latter involve low energy states of the ionised atoms; these normal or metastable states are representd by ^6D, ^5F, and ^4F terms for ionised Fe, Co, and Ni, respectively.

DISCUSSION.

The results presented above confirm the conclusion already arrived at in other ways —that the normal state of the iron atom is represented by a quintet D spectroscopic term, that of cobalt by a quartet F term, and that of nickel by a triplet F term. Practically all of the absorbed lines involve either the normal state or some adjacent metastable state, and the fact that no prominent lines or groups of lines are unac*counted for indicates that the existence of* other terms of lower energy is not probable. This indication is supported by the furnace absorption, and by the astrophysical behaviour of these elements, and it is, fur-

thermore, in perfect accord with quantum-theoretical predictions. The latter are derived from a correlation of spectral terms with the electron configurations which produce them. Thus, for atoms with z *valence electrons in incomplete shells* (z = 8, 9, 10 for Fe, Co, Ni, respectively).

Each arrangement of electrons is responsible for a set of terms, the most prominent ones of which are given above, starting at the left with the term which presumably has the least energy. In each spectrum terms from all three configurations of electrons will appear, but at present the one which will give the normal state can only be determined empirically.

Comparing the absorption data for the three spectra—iron, cobalt, and nickel—we see that the lowest energy term arises in each case from the electron configuration of two $4s$ electrons and z-2 electrons of $3d$ type, but with increasing z there is a progressive approach of the low metastable states to the normal one, and the lowest-energy term from the arrangement $4s$, $3d$ z-1.
acquires more and more prominence in absorption phenomena until in Ni it supersedes the normal state in this respect. Thus, the tendency for group configurations with a lesser number of $4s$ electrons to be preferred, which was noticed in describing the normal states of the Ru-Rh-Pd and Os-Ir-Pt triads of metals (36), is apparently already in operation in the Fe-Co-Ni triad.

SOME IMPORTANT USES OF CARBON DIOXIDE LIQUID.

Liquified carbon dioxide has many and various uses in industry, and many others are being found out. On account of its purity, its non-oxidising quality, its inhibitive action on certain bacteria and its ability to stimulate taste sensation, carbon dioxide has found application in various ways in the food-products industry, its principal outlet being, of course, in carbonated beverages. While the primary reason for carbonating beverages is to give the public what it wants by improving the taste and appearance of certain beverages, carbon dioxide exercises other functions no less important. It accentuates flavours and has a certain psychological refrigerant effect. Further, the bacterial count is steadily reduced in a carbonated beverage on standing. Functionally, carbon dioxide acts as a mild irritant and stimulant, has a direct specific action on the nerve centre controlling respiration, acts as a refrigerant in the form of carbon dioxide snow. Carbon dioxide has been applied successfully to many kinds of fires. It extinguishes flames by keeping oxygen from combustible material or by narrowing the explosive limits of combustible gases. Carbon dioxide is applied in the rubber industry for filling the air-bags which support tyres during vulcanisation. A number of interesting uses depend upon the ability of carbonated waters to dissolve calcium carbonate, and this reaction has been made the basis of cleaning deposits from piping, removing boiler scale, improving the manufacture of raw water ice, etc. An extremely interesting recent European development is the introduction of carbon dioxide into the air in greenhouses and even in open fields for the stimulation of plant growth. Small increases in carbon dioxide concentration in the air seem to produce remarkable effects on growing plants — stimulating their growth considerably.—*The African Chemist and Druggist.*

GENERAL NOTES.

CARNEGIE INSTITUTE OF TECHNOLOGY.

Dr. Thomas Stockham Baker, president of the Carnegie Institute of Technology, Pittsburgh, Pennsylvania, U.S.A., expects to spend six weeks in Europe during February, March, and April of 1928, to organise plans for the Second International Conference on Bituminous Coal at Pittsburgh, according to an announcement from his institution. The first conference, it will be remembered, was held in November, 1926, under the auspices of the Carnegie Institute of Tchnology, and was attended by 1,700 delegates and leading fuel scientists from thirteen different countries. The second conference, which will be held under the same auspices, is scheduled for the week of November 19, 1928.

President Baker's itinerary will include visits to scientists throughout Europe. His European address, after February 25, will be the Guaranty Trust Company, Paris, France.

In connection with the preliminary plans being formulated by President Baker and his associates, it is further announced, a definite decision has been made to include the subject of "Synthetic Fertilisers from

Coal," in the program for the second conference. Other subjects to be considered will probably include the latest development in obtaining substitutes for gasoline from coal, powder from coal, low and high temperature distillation processes, smokeless fuel, gasification of coal, utilisation of coal tar products, and coal in relation to the production of fixed nitrogen.

Formal letters of invitation to be officially represented at the 1928 meeting have been sent to the Ambassadors, Ministers and Chargé des Affaires in Washington of the following countries: Argentina, Belgium, Brazil, Chile, Cuba, France, Germany, Great Britain, Italy, Japan, Mexico, Peru, Spain, Austria, China, Czechoslovakia, Denmark, Greece, Hungary, Norway, Panama, Poland, Sweden, Switzerland, Netherland, and Roumania.

UNITED STATES TRADE CONDITIONS.

Higher unfilled tonnage of United States steel reflects improved metal conditions. Gold exports are increasing. Christmas extra dividend disbursements are approximately 400 million dollars. The 1927 crop returns are estimated at 623,146,000 dols. in value above 1926.

The November export trade balance was 17 million dols. below October, the returns for the month showing exports valued at 461 million dols., and imports at 345 million dols. For the completed months of the year exports are valued at 4,458 million dols., and imports at 3,854 million dols.

November sales of 541 department stores were one per cent. above those of a year ago. Business failures for the week ended 15 December were 441, against 377 a week earlier and 458 a year ago.

BRITAIN'S BIGGEST FAIR.

A practically complete catalogue of the London section of the British Industries Fair was issued this week, with six weeks still to go to the opening of the Fair on February 20.

This advance catalogue, which will be in the hands of trade buyers as far away as Buenos Aires before they leave for the Fair fortnight in England, contains the particulars of the exhibits of 1,125 firms, with index in nine languages. A booklet with it gives the names of the 700 exhibitors in the Birmingham section.

The area actually occupied by the exhibitors' stands at White City, Shepherds Bush, London, will be 250,000 square feet. Almost everything made in Great Britain, apart from the products of the "heavy" industries which exhibit in Birmingham, will be shown.

Taking both sections, the British Industries Fair will be the biggest yet held and nearly twice as big as in 1926.

CANADA'S RECORD MINERAL OUTPUT.

A new high record for mineral production in the Dominions was established last year. According to an official statement of the Mining Department of the Dominion Bureau of Statistics, the total value of mineral output was 241,773,000 dollars, an increase of one and a third million dollars over the figures of last year.

New individual output records were established in gold, copper, lead, zinc, cement and gypsum and in natural gas and petroleum.

Increases were registered in arsenic, cobalt, copper, gold, lead, nickel, platinum metals, zinc and cement.

The gold production totalled 1,825,000 fine ounces valued at 37,731,000 dollars, compared with an output valued at 36,363,000 dollars last year.

Silver production totalled 22,211,000 ounces, valued at 12,488,000 dollars, a decrease in value of 1,400,000 dollars compared with last year. The decrease was largely owing to a fall in the price of silver.

Nickel production increased to 66,000,000 lbs., valued at 15,105,000 dollars, a substantial increase over last year's figures.

Lear production increased to a new high record of 308,000,000 lbs., an increase of 25,000,000 lbs., but owing to lower prices the value of the outpue 16,457,000 dollars, was an increase of only 237,000 dollars.

The value of the output of coal, gas and petroleum was 70,661,000 dollars, an increase of nearly 2 million dollars, the coal production being only surpassed by the outputs of 1923 and 1920. Coal imports for the year included 18,000,000 tons from the United States and 1,037,000 tons from Great Britain.

FISHERY STATISTICS OF CANADA.

The Dominion Bureau of Statistics at Ottawa has just issued its annual report on the Fisheries Statistics of Canada, 1926, from which it appears that the total value of production during the twelve months was \$56,360,633, as compared with \$47,942,131 for 1925 and \$ 44,534,235 for 1924.

The market value attained has only been exceeded twice in the history of the industry, and this only during the war years when prices were much higher than they were in 1926.

Copies of the Blue Book may be consulted by parties interested at the Natural Resources and Industrial Information Branch, the Canadian Building, Trafalgar Square, London, S.W.1.

CANADA'S RECORD TOBACCO CROP.

Canada has harvested this year the largest crop of tobacco ever grown in the Dominion, and it is of uniformly good quality. It is estimated at 43,916,000 pounds compared with 28,824,000 pounds produced in 1926, an increase of 52.4 per cent. Since 1921 there has been a remarkable increase in the area under tobacco in Canada. In fact, the area is now four times what it was six years ago, having been 11,809 acres in 1921 and 44,028 acres in 1927.

There are two main centres of tobacco production in Canada, one of which is located in the St. Lawrence River Valley, near Montreal, and the other in South-Western Ontario. There is also a small district in the Okauagan Valley of British Columbia.

NEW £10,000,000 COLLIERY SCHEME.

Pithead Plants to Produce Petrol and Smokeless Fuel.

Cheaper than Coal.

The promotion of a £10,000,000 scheme for the extraction of smokeless fuel and oils from coal at the pithead was announced on Friday, December 30, 1927, by Sir Arthur Wheeler, Bt., presiding at the annual meetin at the Cannon Street Hotel, of Low Temperature Carbonisation, Ltd.

"There is no doubt," said Sir Arthur, "that for the first time the low temperature carbonisation process is completely successful, both from technical aud commercial standpoints."

The process, according to Sir Arthur Wheeler, aimed at and attained four objects, and independent experts had expressed the opinion that it was a long way ahead of anything else in Europe. The four objects attained were :—

(1) The obviation of the enormous loss due to the burning of raw coal in an open grate.

(2) The production of a fuel (Coalite) as bright as coal but smokeless.

(3) The extraction of oil (including petrol) and gaseous products retaining their chemical and physical properties at their highest possible value.

(4) The utilisation of small coal (slack) which constitutes so large a percentage of the total output of many collieries.

Sir Arthur laid emphasis on the fact that Coalite falls from the retorts in pieces ready for the fire, that it had a higher heat value than coal and was cheaper than coal.

Colliery owners all over the world, he said, are taking great interest in the process. In this country the company is negotiating with several important collieries who have signified their intention of establishing plants, and an agreement has already been reached with an important colliery near Doncaster (the Askern Colliery) for the erection of a plant capable of dealing with 500 tons a day.

It had been decided by the Board to support the establishment, during the next few years, of a scheme for the manufacture of Coalite and the production of oil to a standardised specification by a ring of collieries, in England and Wales. The capital involved in the scheme would probably amount to from five to ten million pounds, but it was not anticipated that there would be any difficulty in finding the money, in view of the national importance of the undertaking, the profound benefits it would confer on the coal industry as a whole, and its contribution towards smoke abatement in all our cities.

Sir Arthur added that the oil obtained by low temperature distillation is much more valuable than oil obtained by the high temperature process. It has a market value much in excess of ordinary fuel or even petrol, and is readily purchased as fast as it can be made.

"The carrying out of the scheme I have outlined," said Sir Arthur Wheeler, "will revitalise our coal industry and, by supplying crnde oils and petrol from our own resources, will materially strengthen the position of this country in time of war."

LARGER ACREAGE OF FIELD CROPS IN CANADA IN 1927.

According to a statement issued by the Dominion Bureau of Statistics, the total area sown in 1927 to the principal field crops in Canada was 54,672,310 acres. This

was an increase of 400,000 acres over the previous year when the cultivated area was 54,273,841 acres. The totals are exclusive of the area devoted to grain hay which will be determined later. Canada's bumper wheat crop was grown on 22,460,154 acres, as compared with 22,895,649 acres in the previous year. Oats occupied 13,239,963 acres, as against 12,741,340 acres in 1926; barley, 3,505,714 acres, as against 3,647,462 acres; rye, 743,311 acres, as against 763,786 acres; and flaxseed, 475,852 acres, as against 738,397 acres in the previous year.

THE INSTITUTION OF MINING ENGINEERS.

In their 38th Annual Report, the Council state that in their two previous Reports the Council referred to the grave anxieties and difficulties under which members of the Institution had laboured in recent years. During the period under review the problems with which the coal-mining industry has been faced have become increasingly perplexing, and all employed in the industry have suffered seriously from the attendant strain and loss. The Council sympathise profoundly with the miners, thousands of whom have suffered great hardships owing to unemployment or short-time working, especially in the coal-exporting districts. They believe, however, that there exists at this date a greater inclination on the part of all directly concerned to recognise that many causes have contributed to bring about the present disastrous state of the industry, the chief of which are to be found in economic world-conditions, and in the cumulative effects of frequently recurring stoppages and upheavals following industrial disputes. The industry cannot hope to recover its prosperity unless all engaged in it wholeheartedly co-operate to restore it to a position which will enable it to compete successfully in the markets of the world, to which end the Institution is devoting its efforts unceasingly. Everyone ought to realise that political interference cannot alter economic laws. The Council believe that the process of recovery has commenced, and that by determined effort and co-operation on the part of all engaged in the industry it may ultimately be restored to prosperity, but that progress towards that desirable end may be painfully slow.

The number of members on July 31, 1927, was 2,993.

Proceedings and Notices of Societies.

SOCIETY OF GLASS TECHNOLOGY.

The one hundred and third meeting of the Society of Glass Technology was held in University College, London, on Dednesday, December 14, 1927.

The following papers were presented and discussed :—

The Analysis of Opal Glasses. By J. H. Davidson, M.Sc., F.I.C., and Miss V. Dimbleby, M.Sc.

The analysis of opal and opalescent glasses was rendered difficult owing to the interference with ordinary course of analysis of the material used to produce the opacity. Opal glasses are of four types, in which the opacity or opalescence is produced respectively by (1) sulphates and chlorides, (2) tin oxide (usually in lead glasses), (3) phosphates, and (4) fluorides—usually in conjunction with aluminous compounds.

The analysis of the first two types does not present special difficulties, but phosphate and fluoride glasses require special treatment.

The method recommended for the analysis of phosphate glasses (if free from fluorine) was to remove the silica from a fusion with alkaline carbonates in the ordinary manner but using nitric instead of hydrochloric acid. The acid filtrate is nearly neutralised and then an excess of solid silver carbonate added, the phosphate precipitated by silver nitrate, filtered off, and the excess of precipitant removed by sodium chloride. The other constituents of the glass can then be determined in the usual manner in the phosphate-free solution.

The method adopted for the analysis of fluoride glasses was that of Berzelius and Rose, which, though tedious to carry out, enabled the silica to be determined without loss due to the volatilisation of silicon fluoride. The fluorine was determined gravimetrically as calcium fluoride.

If the glass contained both fluorides and phosphates, the silica was determined as in the analysis of fluoride glasses and the fluorine and phosphorus obtained in solution as alkaline fluorides and phosphates respectively. The phosphorus was removed by silver carbonate and nitrate as in the analysis of phosphate glasses and the fluorine determinedgravimetri cally as calcium fluoride in the phosphate-free solution.

The two other papers on the agenda were

taken together and presented by Prof. W. E. S. Turner, namely :—

The Effect of Iron Oxide on the Properties of Glass. By S. ENGLISH, D.Sc., H. W. HOWES, M.Sc.Tech., AND PROF. W. E. S. TURNER.

The Durability of Iron-Containing Glasses. By MISS V. DIMBLEBY, M.Sc., AND PROF. W. E. S. TURNER.

The investigations related to a series of glasses of the general composition 6 SiO_2, 2-x Na_2O, x Fe_2O_3. The glasses were melted at 1400° C. in a sillimanite pot which suffered but slight attack. An analysis of the glasses showed that a substantial part of the iron present was in the ferrous state, on the average 15.5 per cent., and was approximately constant for the range of concentration 2.6 to 26 per cent. iron as Fe_2O_3. The glasses grew steadily darker in colour as the iron oxide-content increased, but the colour varied with the extent of oxidation. Prof. Turner discussed the relationship between colour and state of oxidation of the iron, and the extent of dissociation of iron oxide with temperatures, time and glass viscosity. No definite evidenee was found of any marked increase in brittleness in glass due to the addition of iron oxide up to 26 per cent. Detailed references were then made to other properties of the glasses, namely, annealing temperature, thermal expansion, compression strength, tensile strength, and impact strength, from which it was concluded that the presence of iron oxide conferred on glass a number of useful properties.

The durability of the glass was tested by boiling the powdered glass of 20-30 mesh, for one hour in each of the following reagents (a) water, (b) hydrochloric acid of constant boiling strength, (c) twice normal solution of sodium carbonate, and (d) twice normal solution of caustic soda. The results showed that as the total iron oxide contents of the glasses increased, the resistance to the attack of water, hydrochloric acid, and sodium carbonate increased, the rate of this increase diminishing considerably in the higher members of the series. The resistance of the glasses to the action of caustic soda decreased as the iron oxide increased. A general comparison was also made between the iron oxide-containing glasses and glasses containing other oxides which had been previously tested.

GEOLOGICAL SOCIETY.

The following communication was read at the meeting held on December 14, 1927 :

The Lower Carboniferous Rocks of the Menaian Region of Carnarvonshire : Their Petrology, Succession, and Physiography. By DR. EDWARD GREENLY, V.P.G.S.; with Palæontological Notes by DR. STANLEY SMITH, M.A., F.G.S.

The term Arvon is a convenient designation for the Menaian region of Carnarvonshire.

The Lower Carboniferous rocks of Arvon, like those of Anglesey, consist in the main of a limestone series with many beds of sandstone and shale. At the top of the series there is, as in Anglesey, a series of bedded cherts; but the Millstone Grit and Coal Measures are absent, being cut out by the unconformity at the base of the Red Measures. There is a Basement Conglomerate of the normal type, with rolled pebbles of the Mona Complex.

In Arvon, however, this is underlain by a singular formation, composed of yellow and red loams and breccias, which are studded with pisolites of göthite and kaolinite. The blocks in the breccias are angular, and the loams are unstratified. The loams are of alien, the blocks of local, derivation, the blocks not being derived from the same horizon of the Mona Complex as those in the overlying conglomerate. The extent of this formation seems to have been less than 6 square miles.

The limestones are rich in corals and brachiopoda, and are all in the Zone of *Dobunophyllum*, every division of which is present. The sandstones and shales of the Basement Series have yielded plants.

The structure is that of an asymmetrical synclinal infold, truncated by a great boundary-fault.

The Series rests with complete unconformity upon the Mona Complex and the Ordovician rocks; and there is rapid overlap in a west-north-westerly direction. From the direction of the overlap, and from the contents of the conglomerates, it is inferred that the region which is now Snowdonia was completely submerged in Lower Carboniferous times. The pre-Carboniferous land, which was a branch of the ancient uplands of Anglesey, was lofty. On its south-eastern slope, it steepened into a crag, against which the breccias accumulated. This ancient upland was largely composed of Ordovician shales, with a large inlier of rocks of the Mona Complex. Owing, however, to its height, combined with the effects

of the tectonics of the Complex, the outcrops on the inlier were quite different from those on the Menaian Platform of the present day. During the subsidence, different horizons were presented to waste, thus accounting for the contrast between the breccias and the conglomerates.

At first, the climate seems to have been arid, with a large diurnal range of temperature; but, as the subsidence advanced moist and genial conditions began to set in, persisting throughout the remainder of the period represented by the limestone series.

CHEMICAL SOCIETY OF JAPAN.

Papers Communicated :—

Toshi Inoue : A Spectroscopic Method for Detection of the Formation of Complex Salts. Part V. Formation of Complex Salts due to Double Decomposition of Mercury Salts. III.

Ietake Okada : Application of Crystaloptics on the Microscopic Chemical Analysis. Part II. On the Co-ordination Isomers of Cobalt Complex Salts.

Keujiro Kimura : Chemical Investigation of Japanese Minerals containing Rarer Elements. Part XII. Analysis of Allanite of Ishikawa, Iwaki Province.

Kenjiro Kimura : Chemical Investigation of Japanese Minerals containing Rarer Elements. Part XIII. Analysis of Fergusonite of Hagata, Iyo Province.

Kenjiro Kimura : Chemical Investigation of Japanese Minerals containing Rarer Elements. Part XIV. Preliminary Report on New Species of Zircon (Hagatalite and Oyamalite) of Iyo Province.

Saichiro Nagami : Electrochemical Method for Determiuing Chlorine Ion Concentration.

Takio Kato : Studies on Rare Earth Elements. Part I. Gravimetric Determination of Cerium, Lanthanum, Thorium and Zirconium.

Eiichi Funakubo : Studies on Indol-derivatives of Arsenic. Part II. Bye-product obtained by the Preparation of Indol-β-arsonic Acid.

Tessaku Ikeda and Yasuji Fujita : On the Action of Ozone on Acetic Ester of Isoborneol.

Tessaku Ikeda : On the Dehydration of Borneol.

NOTICES OF BOOKS.

Fortschritte in der Kali-Industrie. By Dr. C. Hermann. Pp. vii + 120. Dresden and Leipzig : Theodor Steinkopff. 1927. Price 6 m. 80 pf.

The literature of the potash industry is enriched by this volume in Dr. Rassow's series of Technological Monographs. The industry is no longer purely German and recent improvement also make a new volume on the subject desirable, if not imperative.

The extraction of potassium compounds from carnallite, sylvine and the double sulphates is briefly described, together with an account of the development and improvements in technique. There is an important section on by-products. Although there is nothing new in the information contained in the book it still remains a useful addition to technical literature.

Die Bestimmung der Wasserstoffionenkonzentration von Flussigkeiten. By Dr. E. Mislowitzer. Pp. x + 378. Berlin : Julius Springer. 1928. Price 24 m.

The significaince of the hydrogen ion concentration has attracted the attention of biologists, medical practitioners and other specialists besides the physical chemists interested in this branch of science. To meet the needs of contintental scientists, at Prof. Rona's suggestion, Dr. Mislowitzer has compiled the present comprehensive volume which gives a wide survey of the subject.

The Alkaloids.

Die Fabrikation der Alkaloide. By Dr. Julius Schwyzer. Pp. 125. Berlin : Julius Springer. 1927. Price 10 marks 50 pf.

It is noteworthy that among all the volumes devoted entirely or in part to the alkaloids, not one is devoted to their extraction or preparation on the large scale. Dr. Schwyzer has now written a volume to fill this need. He gives the formulæ, chemical data, physical constants and modes of technical production of the principal alkaloids and their salts. Those considered include quinine and its salts, the opium alkaloids, theobromine, cocain, yohimbine, strychnine and veratrine.

The *Lieferung* 246 of Abderhalden's *Handbuch der biologische Arbeitsmethoden*, Abt. I., Teil 11, Heft 3. Price 22 marks. (Urban & Schwarzenberg, Berlin & Vienna), is also a section on the alkaloids and is by Dr. Reinhard Seka. It deals with these substances both from the theoretical and the biological standpoints.

J. G. F. D.

INDIAN ALCHEMY.

Aasa-jala-nidhu, or '*Ocean of Indian Chemistry and Alchemy*. Vol. II. By BHUDEB MOOKERJI, M.A. Pp. xviii + 296 + 27. London: Messrs. Luzac, 46, Great Russell Street, W.C. Calcutta: The Author, 41a, Grey Street. Price (India) 6 rupees; England and abroad, 15s.

Dr. Bhudeb Mookerji has undertaken the heavy task of compiling, in about ten volumes, a systematic and comprehensive treatise on the almost lost and little known science of Hindu Chemistry. His first volume (see *The Chemical News*, 1927, cxxxv, 190), was well received and the second part has quickly followed it. Succeeding volumes will be awaited with impatience.

In the present volume the author deals with the purification and medicinal use of mica. It was also used to transmute tin into silver (p. 60). Makshikam (pyrites) and shila-jatu (bitumen) are similarly described, as are a number of other bodies used by the earliest alchemists. Most of this volume, however, is taken up with an account of sulphur and preparations from it. Four kinds are mentioned. White sulphur is said to combine with (incinerate) a metal by being smeared on it. The yellow variety, called amala-sara, is 'best suited to the requirements of mercury and of medicine. . . . The red variety is best suited to the requirements of alchemy. The black variety is very rare; it is capable of overcoming senility and death.' The last-mentioned body evidently coincides with the 'philosopher's stone.' The final chapter deals with the 'varieties' of gold, silver, and copper. Dr. Bhudeb Mookerji-s second volume maintains the high standard of his first and is a valuable contribution to alchemical literature.

J. G. F. D.

Slag, Coke Breeze and Clinker as Aggregates. Department of Scientific and Industrial Research. Building Research Special Report No. 10. Roy. 8vo., ppr. wpr.; pp. vi + 22, with 2 half-tone illustrations. Price 9d. net. Postage extra.

Breeze and clinker are used extensively as concrete aggregates, but at present there is very little information available regarding the fundamental causes of the failures which are of too frequent occurrence. Such information as is contained in the literature on the properties of these aggregates and the methods of determining their suitability for building purposes is summarised in the present report. Although scarcely sufficient to permit of definite conclusions it provides some guidance which, owing to the scattered nature of its sources, has probably not before reached the majority of users.

Preliminary investigations at the Building Research Station indicate that, in general, the important factor determining the soundness of these materials is the completeness of the combustion of the coal in the furnace. The marked expansion which has been observed in some concretes is attributable to the unburnt coal in the clinker and the sulphur content of the material is dependent both on the original coal and the degree and method of combustion.

It is hoped that the further experimental work will provide definite information on the properties of clinker and make it possible to evolve reliable tests for its suitability as a concrete aggregate.

The following is a list of the contents:—(1) Introduction; (2) Definitions and Descriptions (blastfurnace slag, coke breeze, pan breeze and clinker, cementing agents); (3) Factors which Affect the Suitability of the Materials for Various Uses (blastfurnace slag (i) acid slags, (ii) basic slags, (iii) effect of sulphur in slags), coke breeze and clinker; (4) Methods of Utilisation (blastfurnace slag (i) poured concrete, (ii) precast blocks, (iii) sound absorbent plasters, coke breeze, clinker); (5) Compression Strengths of Concretes Containing Slag, Coke Breeze and Clinker; (6) Conclusions; (7) Bibliography.

FORTHCOMING EVENTS.

INSTITUTION OF ELECTRICAL ENGINEERS.
Savoy Place, Victoria Embankment, London, W.C.2.
Thursday, January 19.

INSTITUTE OF METALS.

Swansea Local Section, Thomas' Cafe, High Street, Swansea.—Wednesday, January 18, at 7 p.m.—"Some Interesting Properties of the Alloys of Nickel." By W. T. Griffiths, M.Sc.

Birmingham Local Section, at the Engineers' Club, Waterloo Street.—Thursday, January 19, at 7 p.m.—"Heat Resisting Alloys." By T. H. Turner, M.Sc.

THE OPTICAL SOCIETY.
Imperial College of Science and Technology, South Kensington.
Thursday, January 19, at 7.30 p.m.

OIL AND COLOUR CHEMISTS' ASSOCIATION.

—Manchester Section, at Milton Hall, Deansgate.—Friday, January 20, at 7.30 p.m.—Azoic and Other Insoluble Colours." By Dr. A. E. Everest, and J. A. Wallwork. (Joint meeting, Manchester Section, Society of Dyers and Colourists.)

ROYAL INSTITUTE OF PUBLIC HEALTH.

37, Russell Square, London, W.C.1.

Wednesday, January 18, at 4.30 p.m.—"The Medical Practitioner in Relation to the Administration of Justice." By Rowland Burrows, LL.D., Recorder of Chichester.

ROYAL MICROSCOPICAL SOCIETY.

20, Hanover Square, London, W.1.

Wednesday, January 18, 1928, at 7.45 p.m.—Annual Meeting, in the Lecture Hall. Presidential Address by Dr. James A. Murray, M.D., F.R.S., P.R.M.S., on "Staining and Structure."

THE ROYAL SOCIETY.

Thursday, January 19, at 4.30 p.m.

ROYAL SOCIETY OF ARTS.

John Street, Adelphi.

Monday, January 16, at 8 p.m.—Cantor Lecture: "The Scientific Foundation of the Refining of Petroleum." By Albert E. Dunstan, D.Sc., F.I.C.

Wednesday, January 18, at 8 p.m.—Arthur Henry Barker, B.Sc., B.A., M.Inst.C.E.: "Methods of Radiant Heating."

Friday, January 20, at 4.30 p.m.—Indian Meeting: "The Indo-European Telegraph Department." By Maurice G. Simpson, M.I.E.E.

ROYAL INSTITUTION.

Albemarle Street, London, W.1.

Tuesday, January 17, at 5.15 p.m.—Mr. P. R. Coursey: "Dielectrics for Electrical Condensers."

Thursday, January 19, at 5.15 p.m.—Prof. J. F. Thorpe: "Unsaturation of Carbon Compounds."

Friday, January 20, at 9 p.m.—Sir William Bragg: "Photo-electricity."

Saturday, January 21, at 3 p.m.—Prof. R. W. Chambers: "Some Tudor Biographers."

SOCIETY OF GLASS TECHNOLOGY.

January 18, at 2.30 p.m., at Manchester

UNIVERSITY OF LONDON.

University College, Gower Street, London, W.C.1.

Monday, January 16, at 2 p.m.—"The Greek Epic." A public lecture by Prof. M. T. Smiley.

At 6.30 p.m.—"The Literary and Historical Study of the Bible. The New Testament Gospels." By Miss M. S. West, B.D., B.A. Second lecture on January 17, at 6.30 p.m.

At 8.15 p.m.—"Little Plays of St. Francis," Produced by the College Dramatic Society.

Wednesday, January 18, at 3 p.m.—Barlow Lectures on Dante: "La Lirica del Paradiso." First of six lectures, by Dr. Camillo Pellizzi. (Lectures, January 18, 25, February 1, 8, 15, and 22.)

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

35,011.—Standard Oil Development Co.—Manufacture of isopropyl acetate. December 24th.

34,766.—Beavis, J. A. F.—Production of Phosphorescent compositions. December 22nd.

34,662.—Gibson, W. — Manufacture of esters. December 21st.

34,660.—Grace, C. J.—Means of producing emulsion of colloidal sulphur in water. December 21st.

34,327.—I. G. Farbenindustrie Akt.-Ges. —Preparation of latex products. December 19th.

Specifications Published.

282,143.—I. G. Farbenindustrie Akt.-Ges. —Process for preparing quinoline derivatives.

282,168.—Hatfield, H. S., and United Water Softeners, Ltd.—Apparatus for controlling chemical reactions.

282,170.—Hatfield, H. S.—Means for effecting the chemical analysis of liquids and controlling chemical operations.

259,245.—Albert, Dr. A.—Manufacture of crystallised arsenobenzenes.

Abstract Published.

279,884.—Alkylguanidines. — Chemische Fabrik Auf Actien, Vorm. E. Schering, 170, Müllerstrasse, Berlin.

Alkylguanidines are prepared by the interaction of cyanamide, an alkali compound or derivative thereof, with a salt of a higher alkylamine. The reactants are present in equimolecular quantities or with the cyanamide compound in slight excess. Examples are given of the preparation of (1) isoamylhexyl-, heptyl- and phenlyethylguanidines by heating a salt of the corresponding alkylamine with cyanamide in aqueous or alcoholic solution; (2) pentamethylene-, hexamethylene-, and decamethylene-diguanidines from the corresponding diamines and cyanamide; (3) N-methyl-N[1]-hexylguanidine by heating hexylamine with methylcyanamide in alcohol; (4) propyl-, amyl-, isoamyl-, and hexylguanidines by allowing a salt of the corresponding amine to stand with a solution of cyanamide in caustic soda.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

TRIOPHOS.

485,485.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes. — Diamond Fertiliser and Chemical Company, Limited. County Insurance Buildings, Museum Street, York. December 28th.

483,256.—Illustration of a Lamas head and the words " AUCHENIA LAMA," etc., for chemical substances prepared for use in medicine and pharmacy. —Francisco Jauregue and Luis Lancelotti, trading in co-partnership, 341, Callao Street, Buenos Aires, Argentine. December 28th.

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CONTENTS. PAGE.

Stellar Energy, Relativity, Photo-Electric Effect 33
By F. H. Loring.
Further Radiometric Measurements and Temperature Estimates of the Planet Mars 36
By W. W. Coblentz and C. O. Lampland.
Adsorption of Sugars by Animal Charcoal and Decolourising Carbons ... 38
By Norboru Takeomi.
General Notes :—
Foreign Exchanges in 1927 39
Sir John Cass Technical Institute 40
Proceedings & Notices of Societies :—
The Faraday Society 40
Notices of Books 45
Forthcoming Events 46
New Patents 47
New Trade Marks 48

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INDEX DOUBLE NUMBER

VOLUME 135.

Price 1/-, by post 1/1.

STELLAR ENERGY, RELATIVITY, GRAVITY, PHOTO-ELECTRIC EFFECT.

By F. H. LORING.

(*Continued from Page 3.*)

It is well-known that, in dealing with certain optical phenomena, *waves* are treated as *rays*, but when finer analysis is required the *ray method* is not applicable and the *wave method* is then used.

Somewhat similarly, in the case of the Bohr atom, which may be now called the classic method—as so ably developed and expounded by Sommerfeld in his well-known book—the treatment has given way to a finer method of analysis called *wave mechanics*. This was touched upon in a previous issue of this journal.

This new development in atomic physics rests upon the idea of ψ-waves. These waves are small enough to take the place of the electron orbits, so that an electron describing an orbit round the nucleus of an atom automatically disappears from consideration, and in its place ψ-waves are introduced. The first application of this principle was given by L. de Broglie (*Ann. de Physique*, 1925, III, 22).

There is a little book by H. F. Biggs that gives a sketch of the development of this new quantum theory called "Wave Mechanics" (1927). The first paragraph above was suggested by a similar statement in this book, and the following quotation almost immediately following it, on page 25, should give the reader some idea of the initial development. "*If* a ray of ψ-waves were to run round in a circle, it is obvious that, for anything like a stationary state, the circumference must be a whole multiple of the wave-length.

$$2\pi r = n\lambda = nh/v,$$

$$mvr = nh/2\pi,$$

where n is an integer. That is to say, the apparently arbitrary quantum conditions of

the Bohr theory that the angular momentum of the electron must be a whole multiple of $h/2\pi$ is merely the result of postulating that the wave-function ψ shall be *single valued*—for this is the condition that the circumference must contain a whole-number of wave-lengths really comes to. The intra-atomic motion might thus be compared to waves round a circular loop or string, which travel, perhaps, both ways so as to form stationary waves. We should note that in the above argument the velocity v of 'the electron' in the Bohr theory only comes in as a quantity determining the wave-length of the ψ-waves; it is not any physical velocity in our interpretation. As for anything corresponding to the 'position of the electron in its orbit,' there is simply no room for any such conception."

V.

It will be seen that hardly a single subject can be discussed without making excursions into other cognate subjects. In fact the whole set of phenomena under survey requires a section to be given almost to every word used that bears upon physical phenomena.

It will be conjectured, perhaps, that the idea of *spreading radiation* is in some way intimately connected with the new wave mechanics. At any rate the idea discussed here suggests that radiation is a kind of disembodiment of matter, in the sense that when matter, say an electron—or sub-electron if such an entity exists—reaches the speed of light it spreads and becomes so attenuated as to behave quite differently; in short, it becomes light or radiation, that is made up of the original elements of matter, or the original elements of the electron, if this idea be permissible. This is perhaps a part of a greater truth that is hidden.

The equations might be written in the following novel form :—

$$m \longrightarrow c = mc = \text{momentum}$$

$$mc \text{ energy} \longrightarrow = mc^2/2 = \text{energy}$$

but *c-energy*, *i.e.*, energy generated at the velocity of light involves spreading, so that it becomes radiation, therefore, continuing,

$$\tfrac{1}{2}mc^2 \text{ spreading} \longrightarrow = mc^2 \Rightarrow \text{radiation}$$

(*c-energy*).*

It is evident that in reality the mass m would have to be very small—smaller than that of an electron—unless it would be possible to conceive infinitely massive particles, but exceedingly minute. Gravitational difficulties would arise in the latter case. The idea here is something like one advanced by Sir J. J. Thomson some years ago. Thomson's hypothesis is given in the writer's "Atomic Theories," p. 186.

This idea leads to a related one. It will be remembered that Sir Ernest Rutherford suggested the possibility of an electron combining so closely with a proton as to eliminate practically all the possible stray field, and that such a stable neutral particle would have remarkable penetrating properties. This idea has been discussed at length by the writer in the *Chemical News*, 1923, CXXVI, 307, 325, 369; CXXVII, 225.

According to the special theory of relativity an electron, or in fact any mass, moving with the velocity of light (c) would become infinitely massive, but in this case the spreading feature enters into consideration, according to the views here advanced, so that the impossible conception of *infinite* mass is avoided—unless each particle has infinite mass which is difficult or impossible to understand (see above).

If the velocity of light, which is a universal constant, is thought to arise from the conception that the mass of the universe is infinite, or the energy which forms the interchangeable counterpart of mass is infinite, then there should be a representative unit constant. Or, alternatively, to obtain spreading the bullet must be fired with infinite energy and develop infinite mass (see *Chemical News*, Dec. 30, 1927), but these ideas are not realisable if spreading takes place. It will be seen from the equation to follow, which is original with the writer (see *Chemical News*, 1927, CXXXV, 17), that R_{inf} thus stands for potential infinity of mass or energy that is not realised because a limiting phenomenon sets in. Possibly in some such way the universe cannot be infinite in mass, or infinite in extent, but this at best can only be a guess.

The equation just referred to is—

* If the converse of this were true, radiation would have to give up energy to space in giving rise to mass-matter. This suggests that an energy toll, so to speak, may be taken *from* space.

$R_{inf}/24 \times 10^{-33}/h = 2.99796 \times 10^{10} = c,$

when $R_{inf} = 109787.2$,† and $h = 6.556 \times 10^{-27}$. Thus it will be seen that the velocity of light is the ratio of h to R_{inf}.*

† Putting in a branch here, W. V. Houston (*Phys. Rev.*, 1927, xxx, 608) from a new determination of certain λ lines of H and He—assuming the He nucleus to have an atomic weight of 3.9990 whilst the H nucleus is 1.0072—arrived at $R_{inf} = 109737.424 \pm 0.020$. Using this value instead of the one above makes no difference in the value of c as above given, *i.e.*, Michelson's new value, as he allows an error of 1 in the last digit specified. In the R value it may be assumed that the decimal fraction lies between .1 and .5, a mean being .3, which is Birge's best value (previous). Or, taking Paschen's value .11 with a weight of 1, Birge's value .3 with a weight of 2, and Houston's value .424 with a weight of 3, gives a weighted mean of .33.

* The following scheme may be of interest in this connection.

DECIMAL POINT → • 2 *

$2 \times 2 + 1_{-①} = 5$

$2 \times 5 - 2_{-2} = 8$

$2 \times 8 + 4_{-2} = 20$

$2 \times 20 - 6_{-2} = 34$

$2 \times 34 + 8_{-⑤} = 76$

$2 \times 76 - 3_{-6} = 149$

$2 \times 149 + 9_{-6} = 307$

$2 \times 307 - 15_{-6} = 599$

$2 \times 599 + 21_{-⑤} = 1219$

$2 \times 1219 - 26 = 2412$

* DECIMAL FRACTION SO NEAR TO UNITY THAT $2 \times 1 - 0 = 2$.

$$C = \frac{R_\infty}{24 \times 10^{-33}/h} = 29979640852 \cdot \text{ CMS PER SEC.}$$

WHEN $h = 6{\cdot}55\dot{6} \times 10^{-27}$ AND $R_\infty = 109737{\cdot}\dot{3}\dot{7}$

The symmetry may arise from repeating numbers in the constants used. It is of interest to note how near the best experimental values are to the values here brought into agreement.

with intermediate numerical quantities that bring the value to the proper magnitude. The "intermediate quantities" are a disturbing factor it must be admitted, but the ratio of the electromagnetic units to the electrostatic units is also c. Now R_{inf} is the spectroscopically derived constant for the positive nucleus of the atom of effective infinite mass, while h is apparently the electromagnetic constant of radiation, as suggested by the parallelism.

There is thus an interesting feature here. The association of *mass* and *positive electricity* on the one hand, and the association of h with *spreading* (see below) and *frequency* on the other; but the frequency is probably due to, or initiated by, the movement of the negative electron. The counterpart to this extreme activity is the relative inactivity and concentrated non-spreading nature of the positive charge, or the proton; so that the electron and proton are counterparts of each other "in more ways than one." The electron can spread and extend its activity, while the proton remains behind as a shrivelled mass. So it would seem, but the proof as here presented is scanty, yet perhaps suggestive.

It will be seen that the above '*counterparts*' are such as to render it improbable that protons and electrons can combine so as to extinguish each other and produce radiation thereby. The energy of the Sun is therefore more likely to lie in the photo-electric effect. Moreover, the argument leads directly to the idea of h becoming the link with the vast reservoir of space, so that it is only apparently a restricted quantum. In reality it opens the door to space—at least such are the views here offered for what they are worth. In this way h is perhaps linked up with the electron.

From these studies it will be noticed that ideas of space and time, or space-time, tend to change over into a property of the æther*, so that Einstein's equations are not necessarily violated, but substitution of terms, or new definitions of terms, become necessary. The whole of space then becomes a sort of dielectric medium in which electro-magnetic properties play a part (see Section III). Weyl's space is suggestive here. Jeans (*Nature*, March 7, 1925) says :—"In 1918 Weyl pointed out that the geometry of Einstein was not the most general geometry which conformed to the relativity condition. Space could be distorted still further in ways unimagined by Einstein, these further

* Here the word seems inadequate as the æther may be a form of energy : the ætherisation of energy, so to speak.

distortions of the four-dimensional space being specified by the six components of a vector. Now the significant thing is this. On calculating the relations which must hold *between the six components* of the vector, in order that the relativity conditions may be satisfied, Weyl finds equations which are precisely identical with the electromagnetic equations of Maxwell, the six components in question now appearing as the three components of electric force and the three components of magnetic force." Jeans goes on to explain matters further, but the original *article should be consulted.*

The reader will notice how the language used utterly fails to describe the complete conception being evolved, that is to say being *attempted*. This is because the whole truth is not known and in attempting to fit ideas and facts together only a trial approximation can be ventured.

There is an idea in connection with these problems that should not be ignored in the writer's opinion. It will be remembered that Lorentz set up a series of transformation equations based upon the hypothesis that bodies contracted when in motion. Einstein with the same set of equations showed that the principal of relativity, involving the relativity of space and time, was quite sufficient without invoking an æther as Lorentz had done to establish the basis of his contraction, for his contraction was supposed to arise from bodies moving through the æther. Now according to the views here advanced bodies should spread on reaching the velocity of light and this velocity is really the spreading constant. The Michelson-Morley experiment which has been repeated lately with great refinement by R. J. Kennedy (*Nat. Acad. Sci. Proc.*, 1926, xii, 621), and K. K. Illingworth (*Phys. Rev.*, 1927 xxx, 692) shows no change in the velocity of light in the apparatus when orientated with respect to the Earth's motion in its orbit round the Sun. This is favourable to either theory *above as already explained in this article* (see Section II). Suppose, however, another step is made whereby the relativity of time and space is the relativity of energy which dominates space and the ideas of time and space as such cancel out. This would help to explain the equation above, *viz.* :—
$\frac{1}{2}mc^2 \longrightarrow = mc^2 =$ radiation (*c-energy*), the arrow indicating spreading.

The problems here discussed involve so many considerations that should the reader meet with a difficulty he may assume that certain statements are incomplete—perhaps of necessity so. A few examples will serve to make this point. Electrons are discussed as having characteristics diametrically opposite to those of protons, but in one place it is implied that *all* bodies might spread if projected with the velocity of light. The proton might be an exception in this respect. If it were a converse exception it would contract in the same direction relative to its motion. Again, using the word *infinity* is apt to lead to ambiguity, but in that case the *reader can regard matters of impossible* solution for the present at any rate. Statements about electrons turning into radiation are probably inaccurate as they stand; and, the question of reversibility of action is also present as an unsolved feature to be considered. See Lodge : The Æther and Electrons, *Nature*, Aug. 4, 1923. The *wave-mechanics* is so purely mathematical that no physical interpretation seems yet possible, except in so far as de Broglie's ideas have been touched upon. The photoelectric effect as a source of stellar energy is an incomplete statement as the full phenomenon is not known. See Eddington : The Source of Stellar Energy, *Nature*, May 1, 1926.

FURTHER RADIOMETRIC MEASUREMENTS & TEMPERATUE ESTIMATES OF THE PLANET MARS, 1926.

By W. W. COBLENTZ AND C. O. LAMPLAND.

(*Scientific Paper, U.S.A. Bureau of Standards.*)

ABSTRACT.

The measurement of the radiation from the planet Mars at the 1926 opposition is a continuation of the programme of radiometric work on this planet carried on at the Lowell Observatory, Flagstaff, Ariz., at the preceding oppositions of 1922 and 1924.

The telescope used was the the 42-inch reflector, which is equipped with auxiliary mirrors giving focal lengths of 18, 53, and 80 feet.

The radiometers used were a series of thermocouples in vacuum cells. One thermocouple had receivers only 0.12 mm. in diameter and intercepted only 0.01 of the area of the planetary image. These thermopiles were used in connection with an ironclad Thomson galvanometer.

By means of a series of transmission screens of water, quartz, glass, and of

fluorite, the planetary radiation emanating from the irradiated surface of Mars was resolved into spectral components, whereby it was possible to obtain estimates of the planetary surface.

One marked feature of the measurements at the present opposition is the low water-cell transmissions of some of the regions observed; that is to say, the high percentage of the planetary radiation and presumably the high temperature measured. In some instances the water-cell transmissions were as low as 20 per cent.

These radiometric measurements were reduced to temperatures by three independent *methods of analysis giving concordant* results, showing, as previously observed, that the bright areas were cooler than the adjacent dark areas; that the southern (summer) hemisphere was warmer than the northern hemisphere; that the forenoon side was cooler than the afternoon side of the planet—the exception to this rule being sunset clouds, or a dark area on the east limb irradiated for an hour before coming into view.

The temperature differences between the centre of the disc and the limbs (also the poles) appear smaller than previously observed; probably seasonal, being a month after Martian summer solstice instead of a month before as obtained in 1924. In general, temperatures were higher than previously observed, as was to be expected in view of the late summer season.

A conspicuous feature of this year's work was the frequent observation of clouds on Mars which decrease the amount of planetary radiation emitted and give apparently low temperatures.

The following estimates of Martian surface temperatures are given: As viewed on the central meridian, the south polar region, -10° to 10° C.; south temperate zone, 10° to 20° C. (clouds, -10° C.); centre of the disc, 20° to 30° C.; north tropical zone, 5° to 15° C.; north polar region, -25° to -40° C.; sunrise limb (after being irradiated for an hour), -10° C., no phase, -20° C., elonded -35° C.; sunset limb (terminator), -10° C., no phase, 10° C., clouded, -30° C.

CONCLUDING REMARKS AND SUMMARY.

The present series of radiometric measurements concludes three successful attempts, during the oppositions of 1922, 1924, and 1926 in measuring the radiation and estimating the probable temperature conditions on Mars.

The measurements, made during the Martian opposition of 1922, were of a preliminary nature to try out apparatus and methods.

From a comparison of the planetary radiation emitted from Mars relative to that of the moon, which has a temperature of 100° C., or even higher after prolonged insolation, estimates of Martian noonday temperatures of 10° to 20° C. were obtained.

This was the first time in the history of astronomy that direct radiometric observations had been made indicating that the temperature of the surface of Mars rises above the freezing point ,which result is in harmony with visual observations.

During the opposition of 1924 Mars was at its maximum brilliancy (closest approach to the earth) which permitted the observation of small areas on the image of the planetary disc. The thermocouple receivers, which were 0.23 mm. in diameter, interceped only about one-eighth of the diameter of the disc of Mars at opposition and permitted the observation of small dark and bright areas, and also the isolated south polar cap. In this respect the thermocouple, with its minute circular receives, is preeminently adapted for making measurements *of the radiation from isolated areas* on a planetary image. The bolometer or photoelectric cell can not be so readily adapted to such a problem.

The radiometric measurements on Mars, in 1924, were made on 24 nights extending over a period of 10 weeks, under a wide range of instrumental and meterological conditions. These measurements showed that, under a noonday sun the bright equatorial regions of Mars were cooler than the closely adjoining dark regions; that the forenoon side of the planet was at a lower *temperature than the side exposed to the* afternoon sun; and that the south polar region, where it was summer, was warmer than the north polar region. A seasonal variation in the climate was noted, consisting of a gradual rise in temperature of the south polar region as summer advanced on that hemisphere.

By four independent methods of attack estimates of Martian temperatures were obtained as follows: Bright areas -10° to 5° C.; dark areas 10° to 20° C.; north polar region -70° C.; south polar region 0° C. in *spring to 10° C. or even higher at the* summer solstice; sunrise limb -20° C. (bright phase) to -60° C. at opposition; sunset limb -5° to 0° C. at the terminator to 5° C. at opposition.

Coming now to the opposition of Mars in 1926, the principal interest was in obtaining

an extensive series of measurements on the east and the west limbs of the planet for comparison with the measurements of 1924, which, as just mentioned, showed that these two regions differed in temperature, the sunset edge being the warmer.

During the present opposition, when 15 nights extending over a period of about radiometic measurements were made on 15 nights extending over a period of about 4 weeks, it was observed that, as a general rule, the morning and forenoon side of the planet were at a lower temperature than the afternoon and evening side. This was found to be true for about 85 per cent. of the measurements made; the exceptions being warm dark areas on the sunrise limb, or clouds which obscured the sunset limb. The measurements which we have made in collaboration were not sufficiently prolonged to show the marked seasonal change in temperature at the south pole that were observed in 1924. Furthermore, the frequent cloudiness of the limbs prevented the observation of the gradual variation in temperature with phase on the (east or sunrise) limb and the (west) terminator, which variation was observed during the opposition of 1924; although there is some evidence that the temperature of the east and west limbs varied according to phase, as was to be expected.

The 1926 opposition occurred about a Martian month after the summer solstice (August 24) and the surface temperature at the south pole had probably risen to its maximum. The average temperature, over the whole disc, appears to be higher than observed in 1924, and the temperature differences between the centre of the disc and the poles (also between the limb and the terminator) appear to be less than observed two years ago. This is probably to be expected in view of the late summer season, as compared with the last opposition which occured about a month before the Martian summer solstice.

In the foregoing pages the radiometric measurements made on the irradiated surface of Mars during the opposition of 1926 were reduced to temperatures by three independent methods of analysis, which give concordant results showing that the temperature of the centre of the disk, under a noonday sun, is up to 30° C., or even higher. The dark areas are at a higher temperature than the bright areas. In one instance, as observed on the central meridian, the difference was 10° to 15° C.

The temperature in the south polar and south temperate regions, where it was late summer, was much higher than in the northern hemisphere, as observed during the two preceding oppositions.

As already mentioned the temperature of the sunrise limb was observed to be lower than the sunset limb. At opposition, with no clouds visible, the difference in temperature of the limbs was perhaps 10° to 15° C.

A conspicuous feature of this year's work was the frequent observation of clouds on Mars which decrease the amount of planetary radiation emitted and give apparently low temperatures. The afternoon clouds seemed denser than the morning clouds, though this was not necessarily a general condition.

The following estimates of Martian surface temperatures are given (when it was late summer on the southern hemisphere and when viewed on the central meridian): The south polar region -10° to 10° C.; south temperate zone 10° to 20° C. (clouds -10° C.); centre of the disc 20° to 30° C.; north temperate zone 5° to 15° C.; north polar region -25° to -40° C.; sunrise limb (after being irradiated for an hour) -10° C., no phase -20° C., clouded -35° C.; sunset limb (terminator) -10° C., no phase 10° C., clouded -30° C. These values are "black body" temperatures. The true temperatures would be 10° to 12° C. higher.

The observations as a whole completely cerify aud extend our measurements of the two preceding oppositions, showing that the surface temperature of the hemisphere of Mars rises considerably above the freezing point of water, which for years has been a disputed question of considerable importance in the interpretation of the visible phenoment observed on the surface of this much discussed planet.

ADSORPTION OF SUGARS BY ANIMAL CHARCOAL AND DECOLORISING CARBONS.

By NOBORU TAKETOMI.

(*Waseda University, Japan.*)

The author has made experiments on the adsorption of sucrose and grape sugar by animal charcoal (Merck, extra pure, dry) and vegetable decolorising carbons (Norit, Darco and King).

Purification of the sucrose.—The purest commercial sugar (polarization 99.9) was purified in the following manner: Sucrose was precipitated with absolute alcohol

from hot saturated solution, and the fine crystals thus produced were filtered and washed upon a Buchner funnel with the alcohol. The sucrose obtained was redissolved in water again precipitated with alcohol, and washed as above. The second crop of crystals was dried between blotting paper, and preserved in a glass vessel for use.

Purification of the grape sugar—Grape sugar (Merck, extra pure) was dissolved in distilled water and the solution was shaken with animal charcoal and filtered. The filtrate was concentrated under reduced pressure to a thin syrup, shaken with an equal volume of hot 96 per cent. alcohol and filtered from precipitated impurities. The alcoholic filtrate was evaporated under reduced pressure to a syrup and crystallised in a desiccator.

The sugar solution was shaken with animal charcoal for forty minutes and then separated from charcoal by a centrifugal machine. The amount of sugar adsorbed was calculated from the difference of saccharimeter readings before and after treatment. Ventzke readings were measured at constant temperature (20° C.) by using a glass polarization tube with metal jacket, the Zeiss spiral heater and water-pressure regulator being used for controlling temperature.

The results of the experiments may be summarised as follows:—

The amount of sucrose adsorbed by animal charcoal from its aqueous solution, increases with increase of its concentration, but reaches a maximum when the concentration of sucrose solution becomes about 0.2 mol per litre, and then decreases gradually.

When the concentration of sucrose solution is smaller than 0.11 mol per litre, Freundlich's equation holds good for the adsorption of sucrose by animal charcoal. The author has found the following empirical formula:

$$\frac{x}{m} = 0.2829\ C^{0.1264}$$

The amount of sucrose adsorbed by animal charcoal is directly proportional to that of charcoal added. Sucrose is adsorbed considerably by vegetable decolorising carbons (Norit, Darco and King). Grape sugar is also adsorbed by animal charcoal in such amount that the error through adsorption is not negligible in sugar analysis.

GENERAL NOTES.

EXPERIMENTS WITH DRUGS IN MALAYA.

A number of drugs of minor importance, totalling about ten sorts, are being grown at the Serdang Experimental Plantation, Federated Malay States, and enquiries for several of these have recently been received from England. A sample of Ipecacuanha roots was reported on favourably, and an offer made to purchase crops produced. Three species of Chaulmoogra oil trees are under cultivation for the production of seeds in the leper asylums in Malaya. It is hoped to have 30 acres planted with each species.

INSTITUTE OF METALS.

During the past year the membership of the Institute of Metals increased from 1801 to 1903. It is anticipated by the Council that the present year—the twentieth of the Institute's existence—will witness the enrolment of the 2,000th member. Particulars of membership are contained in a booklet descriptive of the work of the Institute, which can be obtained from Mr. G. Shaw Scott, M.Sc., Secretary, 36, Victoria Street, London, S.W.1. The annual general meeting of the Institute will be held in London on March 7-8, and the autumn meeting in Liverpool on September 4-7.

FOREIGN EXCHANGES IN 1927.

The principal events of the year in the foreign exchange market have been the continued advance in the value of the £ in New York from August onwards, and the recent announcement that the Italian Government had decided to return to the gold standard. The firmness of the leading South American exchanges in 1927 was noticeable, and the return of the Argentine Government to the gold standard occurred in August.

The closing quotation for the £ in New York was 4.858 on 1 January, 1927, and from this rate it weakened to 4.849 (the lowest closing quotation recorded in 1927) on the 4, 5 and 7 February. There was a firmer tendency in March, the four weekly averages of 4.852, 4.853, 4.855 and 4.857 indicating the steadiness of the exchange during that month. At the end of August the closing rate was 4.862, parity level (4.866) was reached on 20 September, and on the 24 September the closing rate (4.867)

was slightly in excess of parity. This improvement was more than maintained in October and later months; the closing rates in December varied between 4.880 and 4.884, the quotation for the last day of the year being 4.88 7-32. On balance sterling gained about $2\frac{1}{2}$ cents in 1927.

Italian lire, which closed on 31 December, 1926, at a rate of 108.068 to the £, depreciated during January and the first week of February, the highest closing quotation of 1927 (114.063) being recorded on 7 February. From that date there was a steady improvement, the closing rates on the last days of February, March and April being 110.850, 105.700 and 91.625 respectively. The sustained demand for lire caused a rate of $83\frac{7}{8}$ to be touched at one time on the 26 April, but on profit-taking sales the rate re-acted to 89.625 at the close on that date. On 2nd May the lira declined in value to a rate of 95.125 to the £, but it recovered to 88.188 on the last day of that month. June saw the rate forced down, probably by speculative influences, to below 87 on several days, the closing quotation on the 25 (83.70) being the most favourable recorded to the currency during 1927.

Spain.

One of the few currencies which still lends itself to speculative operations is the Spanish peseta, and the sharp fluctuations which occurred in this currency during 1927 were mainly due to these influences. The closing rate on 31 December, 1926, was 31.70 and on 30 April, 1927, it was 27.590. The monthly averages for the four months January to April (30.322, 28.899, 27.899, and 27.535) show that the peseta, on balance, was steadily appreciating, the impression prevailing that it was the intention of the Spanish Government to allow the rate to approach near parity and then to return to the free gold standard. In November the closing rate again rose, the quotations on the 1 and 30 being 28.50 and 29.730 respectively. December showed a further depreciation, the closing rate on the 31 being 29.89. On balance the peseta appreciated during 1927 by about 6 per cent.

France.

French francs were quoted at 122.800 to the £ at the close on 1 January, 1927, at 123.175 on 1 February, and at 123.995 on 1 March. From that date until the end of the year the rate was virtually stationary at around 124.

Scandinavia.

Of the Scandinavian exchanges, the Norwegian appreciated on balance in 1927, as compared with sterling, by about $4\frac{1}{2}$ per cent., the most favourable quotation of the year (18.32) being recorded in November; the Swedish crown appreciated by about one-third of one per cent., while the Danish crown showed little change in value. Except for a few days early in March and at the end of April the rate for Swedish currency on London was above parity from March to December, and Danish currency was in a similarly favoured position from the middle of July to nearly the end of August. Norwegian currency was still about 1 per cent. below London parity in December.

On balance in 1927 there was no considerable movement in the rates of the Continental gold currencies on London. Reichsmarks steadily depreciated in the first five months, the quotation reaching 20.54 on 11th May, the highest figure recorded since the currency was stabilised; they recovered from June to November, being actually at a premium, as quoted in sterling, on most dates in October and November, and closed the year at an exchange value slightly below parity. Belgas depreciated until the middle of the year, subsequently improving until September.

SIR JOHN CASS TECHNICAL INSTITUTE.

A pleasing indication that the executive control and administration of chemical works is passing into the hands of chemists is furnished by the announcement that the Sir John Cass Technical Institute has added a short course of lectures on "Law as related to Industrial" Chemistry " to its curriculum. The governing body of the Institute have wisely arranged for the lectures to be given by a professional chemist and practising barrister (Mr. G. S. W. Marlow, B.Sc., F.I.C.), and by holding them in the evenings (Tuesdays at 7 p.m.) they have made it possible for those already engaged in industrial work to attend. The necessity for some legal knowledge by anyone holding a responsible executive appointment is too obvious to require comment, and the course should prove very popular both with chemists already engaged in industrial work and with students preparing for an industrial career. At the first lecture, which is to be held on January 24, the chair will be taken by Mr. James Whitehead, K.C.

SOME APPLICATIONS OF THE THEORY OF COMPLETE IONISATION. THE CHEMICAL CHARACTER OF STRONG ELECTROLYTES.

By Professor T. M. Lowry, F.R.S.

(Before the Faraday Society, April 28, 1927.)

I.—The Theory of Complete Ionisation.

The theory of complete ionisation had its origin in a physico-chemical study of the properties of solutions; but it was very soon adopted by physicists as an explanation of the high symmetry of the crystal-structures revealed by the X-ray analysis of metallic salts, since this could not be accounted for on the traditional theory that the ions of the salt were united into molecules. The new theory has had a large measure of success in both fields of study, since, on the one hand, the conductivity of solutions of ordinary metallic salts has been calculated for the first time by means of a rationally deduced formula, which is valid up to a concentration of perhaps N/10; on the other hand, many of the physical properties of crystals, such as their linear dimensions and angles, heat of formation, elasticity, refractive index and infra-red absorption, have been calculated successfully on the assumption that the crystals are aggregates of ions of varying degrees of "hardness," which are drawn together by the electrostatic attraction between their opposite charges, but are also repelled from one another with a force varying inversely as (say) the 6th to the 35th power of the distance. On the other hand, the theory of complete ionisation (which cannot be expected to "have it both ways") fails to cover the behaviour of those weak electrolytes which obey Ostwald's dilution Law, just as completely as the latter law failed to cover the behaviour of highly-dissociated metallic salts. Again, although many of the properties of solid ionic aggregates, such as rock salt or calcite ,have been predicted successfully from fundamental data, all attempts to predict the dimensions and behaviour of the carbonate ion itself have failed, since this does not behave as a mere aggregate of carbon and oxygen ions. The object of the present paper is therefore to determine the boundaries of the region within which the theory of complete ionisation is valid, to find out the factors which make it inoperative in so many cases, and in particular to study the chemical significance of the classification of electrolytes as "strong" and "weak." The applications of similar considerations to the study of crystal-structure will form the subject of a subsequent communication.

In both cases the principal argument put forward will be that, although the ions of a salt are generally prevented from neutralising their opposite electric charges by factors which find their simplest expression in the "octet" rule, there are many cases in which this inhibition does not operate, with the result that the ions can be converted into real molecules, as distinguished from mere aggregates of ions, by the neutralisation of their opposite charges with formation of a chemical "bond." These two groups of compounds correspond broadly with the "strong" and "weak" electrolytes; but the two methods of classification cannot be expected to lead to identical results. Thus, on the one hand, a salt which consists entirely of ionic aggregates may be placed under conditions which are so unfavourable to the independent migration of the ions as to bring it within the group of "weak electrolytes"; and, on the other hand, the bond which holds the positive and negative radicles together in a covalent molecule may be so weak as to interfere but little with the disruption of the molecule into ions, with the result that a compound of the second type may exhibit the behaviour of a strong electrolyte.

II.—Electrolytic Dissociation of Strong Electrolytes.

A "strong electrolyte" means, in the first instance, nothing more than a substance which has a high electrolytic conductivity, *e.g.*, in aqueous solutions. In the language of Arrhenius' theory ,such a substance was said to have a large "coefficient of ionisation"; but this term has no longer any real meaning when applied to a salt which is 100 per cent. ionised even in the solid state. We can, however, still interpret the decrease of equivalent conductivity in strong solutions as being due to the formation of electrically-neutral doublets, which play the part of molecules, just as in the vapour of the salt. We need therefore only modify Arrhenius' equation to the extent of writing

$$\overset{+}{Na}\overset{-}{Cl} \rightleftharpoons \overset{+}{Na} + \overset{-}{Cl} \text{ instead of}$$

$$Na - Cl \rightleftharpoons \overset{+}{Na} + \overset{-}{Cl}$$

The "degree of dissociation" of the doublets then has still a perfectly definite physical meaning ,even if it cannot be cal-

culated directly, as was formerly supposed, from the simple equation $a = \Lambda / \Lambda^{\infty}$. Moreover, since the readiness with which neutral doublets of oppositely charged ions are formed by the mutual attraction of their electrostatic charges must vary with the linear dimensions of the ion, with the dielectric constant and other properties of the solvent, and with the extent to which the naked ion becomes hydrated or solvated in solution, as well as with the temperature at which the association and dissociation of the ions takes place, there is ample scope, even in the theory of complete ionisation, for variations in the "degree of dissociation" of different salts, either in solution or in the fused state.

(a) Ionisation of Strong Electrolytes in Solution.—Is is possible, then, for a completelp ionised salt to behave as a "weak electrolyte" and exhibit a low "coefficient of ionisation," or, more accurately, a low "degree of dissociation" of the pre-existing ions? The answer is undoubtedly "Yes," provided always that the conditions under which this effect is theoretically possible can be realised in practice.

Of these conditions the most obvious has reference to the nature of the solvent. Thus Hartley has shown that, in the case of N/500 KI ,the ratio $\Lambda / \Lambda^{\infty}$ falls from 0.98 in water to 0.90 in methyl alcohol, 0.81 in ethyl alcohol and 0.77 in acetone, although his solutions were all so dilute that $1 - a$ was still proportional to the square root of the concentration as required by the theory of complete ionisation. If then we accept the general validity of Walden's rule, that *a dissolved salt gives a definite value for $\Lambda / \Lambda_{\infty}$ at a dilution which is proportional to the cube of the dielectric constant of the solvent*, it follows that we should be able to repress the dissociation of the ions to any desired extent by dissolving the salt in a medium of low dielectric-constant.

At this point, however, a fresh difficulty present itself, since the majority of metallic salts are insoluble except in media which possess marked ionising properties; in particular, most of these compounds are completely insoluble in media, such as benzene or cyclohexane, where the dielectric constant is low enough to compel the salt to behave as a weak electrolyte. Walden has, indeed, put forward a definite rule, according to which *the coefficient of ionisation of a salt is approximately constant for saturated solutions in any anhydrous solvent.* Thus in the case of tetraethylammonium iodide, we should not expect to find any solution in which the "coefficient of ionisation" is much below 50 per cent., since saturated solutions in a dozen different solvents (but excluding water and all other solvents in which the solubility is more than 1 gram-molecule in 2,500 c.c.) gave values for $a = \Lambda / \Lambda_{\infty}$ which were almost constant at 0.18. ceptional cases will it be possible to prepare a solution of a strong electrolyte in which the coefficient of ionisation is so small as to be negligible, and that this effect when it occurs, will probably be due to some special chemical relationship between the solvent and the solute, which enables ,the solute to dissolve, but without any marked disruption of the ions.

Such an effect mught be looked for in Reychler's trimethylcetylammonium cetylsulphonate ,

$$\overset{+}{C_{16}H_{33} \,.\, NMe_3} \quad \overset{-}{O \,.\, SO_2 \,.\, C_{16}H_{33}}$$

in which the single polar valency in the middle of so long a chain of atoms might very well remain almost undetected. Thus, whilst the 30 carbon atoms in the two hydrocarbon chains should suffice to make the compound soluble in hydrocarbon solvents, these solvents need not necessarily be so drastic in their action as to force the two ions apart. Fortunately, however, this phenomenon can be observed in much simpler compounds. Thus, sodium oleate at a dilution of 100 litres gives the following equivalent conductivities in water and in methyl, ethyl, and amyl alcohols

	H_2O	CH_3OH	$C_2H_5 \,.\, OH$	$C_5H_{11} \,.\, OH$
ϵ	81.7	35.4	25.4	15.6
Λ^{18}_{100}, Λ^{25}_{100}	30.09	0.0052	0.0018	0.0002

When sodium oleate is dissolved in *water*, the "hydrophilous" sodium ion compels the "anhydrophilous" oleate ion to follow it into aqueous solution, where it functions as the "ionic micelle" of a "colloidal electrolyte." In the alcohols, on the other hand, and especially in amyl alcohol, the oleate radical appears to drag a reluctant sodium ion into solution in *an organic solvent ,in which the salt behaves for all practical purposes as a non-electrolyte.*

Walden however, has gone a great deal further in studying the abnormal conductivities of salts in hydrocarbons and in their halogen derivatives. Thus, by a suitable choice of radicals, in salts such as $N(C_5H_{11})_4I$, *he has been able to obtain solutions* of reasonable strength in a dozen of the least promising solvents, including benzene and toluene, methyl iodide, methylene and ethylene chlorides, chloroform and carbon tetrachloride. In every case, the salt-solution showed an appreciable conductivity, the values for Λ^{25}_{20} varying from 0.0140 in carbon tetrachloride to 1.57 in chloroform and 9.51 in methylene chloride; but the equivalent conductivities were abnormal in that they generally fell to a minimum value at some intermediate dilution, from which there was not only the usual increase on dilution, but an equally striking increase on passing to more concentrated solutions. The coefficients of ionisation, however, were obviously small and in some cases almost negligible, so that the "salt" was behaving quite clearly as a "weak electrolyte" in all these solvents. Neutralisation of the ionic charges, however, would appear to be even more difficult than usual, in view of the fact that the positively-charged nitrogen of the tetra-amylammonium ion is separated from the negatively-charged halogen ion by a permanent hydrocarbon "atmosphere" containing 20 atoms of carbon. The small conductivity of these solutions then suggests that the salt must be present predominantly in the form of neutral ionic doublets, rather than as freely dissociated ions. The formation of these doublets also appears to afford a suffi*cient explanation of the different absorption-*coefficients which a sufficient explanation of the different absorption-coefficients which Hantzsch observed when quaternary ammonium salts of this type were dissolved in organic solvents instead of in water, since we need not suppose that the absorption-coefficients of the ionic doublet must necessarily be identical with those of the aqueous ions.

(*b*) *Ionisation of Fused Salts.*—Since considerations of limited solubility do not apply in the case of fused salts, it is of special interest to enquire what is known in reference to the magnitude of the "coefficients of ionisation" under these conditions. It has been generally assumed that the calculation of these coefficients is impossible, since it cannot be done either by Arrhenius' method, which depends on measuring the conductivty of the salt at different stages of dilution with a solvent, or by van't Hoff's method, which implies a knowledge of the osmotic pressure of the salt in solution. A formal solution of the problem is possible, however, in the case of fused silver chloride at 600° C., for which the relevant data are all known, namely:

Molecular weight	M	$= 143.34$
Density	δ	$= 5.267 - 0.0092t = 4715$ at 60°
Specific conductivity	κ	$= 4.48$ at 600°
Viscosity	η	$= 0.01606$ at 603°.

The normality of the fused salt is $4715 \div 143.34 = 32.9N$; and the equivalent conductivity is therefore $\Lambda = 4.8 \div 0.0329 = 136$. The limiting value for the conductivity at infinite dilntion in aqueous solution is given by the sum of the ionic mobilities as $54 + 65 = 119$; if, therefore, a proportional allowance is made for an increase of viscosity from 0.01506 to 0.01606, the corresponding limiting value for the fused salt would be $A = 119 \times 0.01056 \div 0.01606 = 78$. The equivalent conductivity of a completely ionised salt can, however, also be calculated, without making use of the value for aqueous solutions, by means of Walden's relation, $\Lambda_x \eta_x \sqrt{M} = 1\ 1.15$, which has been verified for six salts in 29 non-aqueous solvents, as well as for two "anhydrous" salts in aqueous solution. For silver chloride this relation gives $\Lambda = 11.15 \div 0.01606 \div 12 = 58$.

These two methods of calculation concur in giving a maximum conductivity for completely dissociated silver chloride, $AgCl \rightarrow \overset{+}{Ag} + \overset{-}{Cl}$, which is only about half as great as the values found experimentally. It has been suggested, and the idea has found widespread acceptance, that the exceptional mobility of the ions $\overset{+}{H}$ and $\overset{-}{OH}$ in aqueous solutions is due to the fact that they are *the ions of the solvent.* This idea is at least *plausible in the case of water, where it* might be supposed that the exceptional mobility of $\overset{+}{H}$ (in the form of $\overset{+}{OH_3}$, since $\overset{+}{H}$ cannot be present as a separate entity), depended in part on the transfer of a naked proton from one complex to another, without necessarily involving the migration of the whole of the oxonium ion; but it is not

valid even in the closely related case of liquid ammonia, where $\overset{+}{H}$ (in the form of $\overset{+}{NH_4}$) and $\overset{+}{NH_2}$ are less mobile than $\overset{+}{K}$ and $\overset{+}{Tl}$; and there is no reason why it should be true in the case of a completely ionised salt, where it is difficult even to suggest a theoretical justification for it. It therefore appears more likely that the high conductivity of fused silver chloride may be due to the presence of something analogous to the "ionic micelle" in a colloidal electrolyte, *i.e.*, to complex aggregates of ions carrying multiple electric charges, since these would have the effect of increasing both the viscosity and the electrolytic conductivity of the melt. Such aggregates might be formed by an incomplete destruction of the crystal lattice and it may be supposed that the conductivity of a fused salt is determined very largely by the character of the aggregates that persist when the crystalline salt is melted.

From this point of view it is of interest to notice that all fused salts are not good electrolytes, even when the theory of valency indicates that they must be completely ionised. Thus, leaving out weak electrolytes such as $SnCl_4$ and $HgCl_2$, where covalent molecules appear to be formed from the metal and the halogen, the values

$$\Lambda^{70} = 0.0009, \Lambda^{100} = 0.0050$$

recorded by Walden for the molten hydrobromide of dimethyl-aniline, present a remarkable contrast with the values

$$\Lambda^{600} = 4.48, \quad \Lambda^{800} = 4.98$$

for silver chloride. In this compound we must either suppose that the fused solid breaks up into electrically neutral doublets, $[\overset{+}{N}HPhMe_2\ Br]$, in which the oppositely charged ions cling together, just as they must do in a salt-vapour of normal vapour-density and, therefore, do not migrate in opposite directions under the influence of a small electro-motive force; or we must postulate the existence of some snbtle type of bond, which binds the ions into a molecule of such an unstable character that it is unable to persist in aqueous solution (compare Hantzsch's hypothetical pseudo-ammonium halides). Until, however ,the existence of such molecules has been proved, it is simpler to admit that a salt, even if it is completely ionised in the crystalline state, will not become a good electrolyte when fused, unless the lattice is resolved into oppositely-charged fragments. If the cleavage of the lattice on fusion tends predominantly to produce neutral ionic aggregates like those which are formed on vaporisation, the conductivity of the fused salt may be reduced to such an extent as to give rise to the properties of a typical "weak electrolyte." This effect, it is clear, is most likely to appear in salts which are easily vaporised, *i.e.*, which break down readily into volatile neutral doublets.

Proceedings and Notices of Societies

THE ROYAL SOCIETY.

Thursday, January 19, 1928.

Among the papers read were the following :—

Enzymatic Function of Mitochondria in the Germinaton of Cereals. By E. S. Horning and A. H. K. Petrie. Communicated by A. J. Ewart, F.R.S.

In resting stage of maize grain mitochondria occur in moderate numbers in scutellum and endosperm. During germination they become numerous in scutellum, and are secreted in large numbers from epithelial cells into adjacent starch-containing cells of endosperm. These secreted mitochrondria aggregate round starch grains prior to their corrosion. As corrosion commences the associated mitochondria seem to disappear. Throughout the period of endosperm depletion, mitochondria are thus secreted and migrate through the emptied cells to the zone of active hydrolysis, where they become associated with the starch grains in this manner.

This behaviour of mitochondria appears to lend support to the enzymatic conception of mitochondrial activity, supposing the starch-splitting enzyme located within them or at their surface, and liberated when these bodies reach the surface of the starch grains.

During germination mitochondria originally present in endosperm increase by fission, although the same profuse numbers are not found as from scutellum. In isolated endosperms these mitochondria of intracellular origin effect starch hydrolysis and depletion at a slower rate corresponding to their lesser numbers.

There is no evidence for secretion of mitochondria from aluerone layer or of depletion being affected by secretion of enzyme therefrom.

Similar secretion of mitochondria from epithelial cells of scutellum takes place during germination of wheat and barley.

Triplet Children in Great Britain and Ireland. By R. A. FISHER. Communicated by Sir Arthur Keith, F.R.S.

Existing data on twins have given rise to much difference of opinion on heredity of twinning tendency; moreover, good measurements are exceedingly scanty. In order to obtain data from a fresh source, in the collection of which adequate safeguards could be taken against the chief causes seeming to have vitiated twin material, an enquiry was commenced on triplet cases recorded as recipients of the Royal Bounty. Results of measurements, and of genealogical enquiries on three years' data from this source, are given.

Six physical measurements taken on 117 children show correlation between pairs of unlike sex conformable with that obtained by the author from Lauterbach's measurements on twins, and with that between adult brothers and sisters. Pairs of like sex are more highly correlated, the results being well fitted by the supposition that about 54 per cent. of the surviving like-sex pairs are monozygotic in origin, and that these have a correlation 0.94.

Relationship data confirm paternal influence, and sex distribution of related twins strongly suggests that this is confined to causation of di-embryony. If maternal influence conditions both dizygotism and di-embryony, the slightly higher values obtained from these and other data for maternal influence indicate that, contrary to Weinberg, di-embryony is the more strongly inherited phenomenon—a view in accord with the large known effect of mother's age on dizygotism.

The Differential Effect of the Ions of Three-Salt Solutions on the Growth of Potato Plants in Sand Culture. By F. G. GREGORY. Communicated by V. H. Blackman, F.R.S.

A method of statistical analysis is developed enabling assessment of the effect of single ions on growth of plants in culture solution consisting of mixture of salts, and has been applied to data published by E. S. Johnson ("Growth of Potato Plants in Sand Cultures treated with Six 'Types' of Nutrient Solution").

It is found that the kations in the solution have for each relative ionic concentration (ionic proportion) a greater effect than any of the anions used. The effects of the six ions used are presented numerically and graphically for the ions singly and in molecular combinations.

Agreement of predicted values for yield in solutions employed by Johnston is compared with his experimental results. Agreement between predicted values and experimental values proves to be closer than agreement found between duplicate experimental sets of results.

Experimental Researches on Vegetable Assimilation and Respiration—Parts XVII and XVIII. By E. J. MASKELL. Communicated by F. F. Blackman, F.R.S.

In cherry-laurel leaves at limiting concentrations but under *constant* lighting there is marked diurnal rhythm of apparent assimilation, falling to very low values at night and rising in morning. At any point in the diurnal march assimilation can be increased by increasing CO_2 up to limit set by light-intensity used. The observations suggesting that the variations in assimilation are largely due to variations in the stomatal opening, this is tested by means of parallel observations on assimilation rate and porometer rate.

It is shown that diurnal rhythm of assimilation is due to a rhythm of stomatal opening. At small opening assimilation rate is approximately proportional to porometer rate. As stomata open and porometer rate increases, assimilation rate approaches asymptotically to a level determined by non-stomatal resistances in diffusion path of CO_2 and in phases of photosynthesis.

Results of analysis for assimilation rate are expresed in equation form in terms of stomatal diffusive capacity, of diffusive capacity of intercellular spaces, etc., of seasonal photosynthetic efficiency, of light intensity and of CO_2 concentration.

THE INSTITUTE OF CHEMISTRY.—DANCE.

Members are reminded that the Annual Dance will be held on Wednesday, February 15, and as hitherto, at the Hotel Russell. Tickets, inclusive of refreshments, 7s. 6d. each, or 14s. double ticket. These can be obtained on application to the Hon. Sec., at the Institute, 30, Russell Square, London, W.C.1.

BRITISH SPHAGNUM MOSSES.

An Illustrated Handbook of the British Sphagna. By W. R. SHERRIN, A.L.S. Pp. 74. London : Taylor & Francis, Red Lion Court, E.C. 1927. Price 6s.

That mosses have played an important role in the scientific and cultural advancement of mankind is not generally realised. Mosses or some plants resembling them, constituted the earliest land flora. To-day, peat, the partially carbonised sphagna of past ages, is an important fuel in many parts of the world.

The elastic, bulky and light sphagna find some modern applications as packing material, stable litter in place of straw, and are used by orchid growers. Dry sphagnum moss is able to absorb over twenty times its weight of water and such mosses were successfully used during the war as bandages, especially by the Germans.

In his Foreword to Mr. Sherrin's *Illustrated Handbook*, Mr. Dixon mentions that not only is Horrell's *European Sphagnaceae* out of print, but the system of Warnstorf's, on which it was based, is now somewhat out of date, that authority on these mosses having considerably altered his views in recent years so that his latest system differs quite markedly from that upon which Horrell based his treatment.

The present work is limited to species and varieties recorded for Great Britain. Even a cursory study of the habits of the Sphagna will show that the most readily recognisable species are those like *S. compactum* and *S. Tenellum* and the Cymbifolia generally, which are found on higher or drier parts of bogs, or even on heathland together with *Erica*. The Subsecunda and Cuspidata groups of species are, however, very variable and exhibit many perplexing forms. Mr. Sherrin describes forty-eight species as British, established varieties for most of which are also recorded.

Many thousands of specimens have passed through Mr. Sherrin's hands and he has made careful use of his experience in compiling what will be regarded as the standard work on the subject.

J. G. F. D.

THE CHEMISTRY OF CELLULOSE.

(1) *Lehrbuch der Cellulosechemie.* By PROF. EMIL HEUSER. Third edition. Pp. x + 278. Berlin : Gebruder Borntraeger. 1927. Price 16 marks 80 pf.

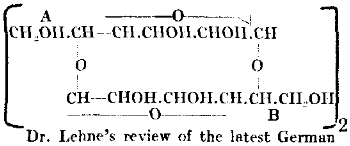
(2) *Textilchemische Erfindungen.* By DR. ADOLF LEHNE. Pp. VIII 100. Verlag A. Ziemsen, Wittenberg, Halle. 1927. Price 10 m.

The first of these important volumes is primarily intended for students in Technical Institutes and Universities and for specialists in the many branches of the cellulose industries.

So much is now being discovered and applied rapidly on a large scale in the field of cellulose chemistry that many of the practices of a decade ago are already obsolete. The earlier literature on cellulose is now largely out of date and the third edition of Prof. Heuser's book will find a wide number of readers both in Germany and also here. His work deals with the alcoholate compounds (mercerisation); esters (chiefly nitrates, acetates and xanthogenate—viscose); the oxidation, building up and constitution of cellulose and finally with the recent X-ray studies on cellulose.

It is remarkable that so few serviceable cellulose esters have been obtained. The reviewer, under the guidance of on of the authorities quoted (but wrongly spelt) by Prof. Heuser, spent some time attempting to prepare definite higher fatty acid esters of cellulose. Some of these, it appears, are now known but have no applications.

The chapter devoted to the constitution of cellulose, discusses the various formulæ that have been proposed, and the author inclines to Karrer's dimeric anhydrocellobiose formula :



Dr. Lehne's review of the latest German patents covering the dyeing, bleaching, mercerisation, washing and chemical treatment of textiles deals with those granted between June, 1926, and July, 1927. It is apparently the first issue of what will be a series of volumes which should prove useful to industrialists and others concerned with textiles.

J .G. F. D.

FORTHCOMING EVENTS.

INSTITUTE OF METALS.

Sheffield Local Section.—Friday, January 27, at 7.30 p.m.—(Applied Science Department, University, St. George's Square). "All-Metal Aeroplane" Lecture.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

36, George Street, Manchester.

Chemical Section.—Friday, January 27, at 8 p.m.

PEOPLE'S LEAGUE OF HEALTH.

11, Cavendish Street, Cavendish Square.

Wednesday, January 25, at 6 p.m.—(Particulars from Miss Olga Nethersole, R.R.C., 12, Stratford Place, London, W.1.)

ROYAL INSTITUTE OF PUBLIC HEALTH.

37, Russell Square, London, W.C.1.

Wednesday, January 25, at 4.30 p.m.—"Tests for Drunkenness, Particularly in Relation to Motor Accidents." By Godfrey Carter, M.B.Vict., D.P.H.

ROYAL SOCIETY OF ARTS.

John Street, Aledphi, London, W.C.2.

Monday, January 23, at 8 p.m.—Cantor Lecture, by Albert Ernest Dunstan, D.Sc., F.I.C.

Wednesday, January 25, at 8 p.m.—"Enamels." By H. de Koningh.

ROYAL INSTITUTION.

21, Albermarle Street, Loudon, W.1.

Tuesday, January 24, at 5.15 p.m.—Mr. P. R. Coursey: "Dielectricts for Electrical Condensers."

Thursday, January 26, at 5.15 p.m.—Prof. J. F. Thorpe: "Unsaturation of Carbon Compounds."

Friday, January 27, at 9 p.m.—Miss D. A. E. Garrod: "Prehistoric Cave Art."

Saturday, January 28, at 3 p.m.—Prof. R. W. Chambers: "Some Tudor Biographies."

THE ROYAL SOCIETY.

Thursday, January 26, at 4.30 p.m.

THE PHYSICAL SOCIETY.

At Imperial College of Science, South Kensington.

Friday, January 27, at 5 p.m.

UNIVERSITY OF LONDON.

University College, Gower Street.

Monday, January 23, at 2 p.m.—"Virgil and the Epic of Rome." By Prof. H. E. Butler.

At 4.15 p.m.—"La Mise en Scène dans le Théâtre du Moyen Age." Public lecture in French, by Prof. L. M. Brandin.

Tuesday, January 24, at 5.30 p.m.—"Amsterdam in the Seventeenth Century." First of two lectures by Prof. P. Geyl. (Other lecture, January 31.)

Thursday, January 26, at 5.15 p.m.—"Customary Law in the British Empire: *Asia and the Pacific.*" *First of six lectures* by Prof. J. E. G. de Montmorency. (Other lectures, February 2, 9, 16, 23 and March 1.)

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

35,451.—Classen, P. A.—Process for removing hydrochloric acid from sugar solutions, etc. December 31.

35,338.—I. G. Farbenindustrie Akt.-Ges.—Synthetic production of methanol. December 30th.

35,321.—Lockwood, A. A.—Process for removal of sulphur from oil. December 30th.

35,285.—Plausou, H.—Accelerating chemical reactions. December 30th.

35,457.—Techno-Chemical Laboratories, Ltd.—Drying-apparatus. Decembes 31st.

Specifications Published.

282,487.—Hatfield, H. S.—Apparatus for automatically determining the amount of gas existing in water and the automatic control of chemical operations.

282,559. Selden Co.—Process of carrying out exothermic chemical reactions.

271,103.—Consortium fur Elektrochemische Industrie Ges. — Manufacture of butyric aldehyde.

Abstract Published.

280,373. Aromatic acid anhydrides.—British Dyestuffs Corporation, Ltd., Hexagon House, Payman, J. B., and Hall, N., Crumpell Vale Chemical Works, both in Blackley, Manchester.

Benzoic and other aromatic acid anhydrides are produced by treating bodies of the type of benzotrichloride with water or the corresponding acid in presence of a catalyst which is an inorganic or organic salt such as a chloride, sulphate, oxide, benzoate, or sulphonate of a heavy or polyvalent metal such as zinc, copper, iron, aluminium, or tin. In the examples, benzoic anhydride is obtained by treating benzotrichloride at 100-105° C., with water in presence of pumice containing zinc chloride; benzotrichloride is heated at 110-115° C. with dry ferrous sulphate or ferric chloride and benzoic acid; and benzotrichloride is heated as in the first example with ferrous sulphate crystals instead of the water and zinc chloride catalyst, the water being obtained from the crystals. Specification 2878/80 is referred to.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

TYTOXA.

485,886.—Chemical substances prepared for use in medicine and pharmacy.—John Connolly Carroll, 60, Windsor Road, Forest Gate, London, E.7. January 4th.

VULA.

485,308.—Chemical substances prepared for use in medicine and pharmacy.—William Pearson, Limited, 61, Mark Lane, London, E.C.3. January 4th.

DURUNDA.

485,874.—All goods in class 1 which includes acids, potash salts and other chemical substances used in manufactures.—Arthur Sanderson & Sons, Ltd., 52, 53, 54 and 55(Berners Street, London, W.1. January 4th.

GERMAN CONVERSATION AND LESSONS GIVEN.

Translations Undertaken.

Write, S. G., c/o *Chemical News*, Merton House Salisbury Square, London, E.C.4.

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CONTENTS. PAGE.

The Structure of an Atom of Nitrogen. Part VI. ... 49
By Hawksworth Collins, B.A. (Camb.).
A Brief Review of the Principal Base Metal and Base Mineral Resources of the Union of South Africa ... 51
By C. J. C. Jourdan.
General Notes :—
Wholesale Prices in 1927 ... 55
Royal Society of Arts Competition of Industrial Designs ... 55
U.S.A. National Wealth and Industrial Conditions ... 56
Royal Institute of Public Health Forthcoming Congress in Dublin ... 58
The Chemical Society ... 59
Notices of Books ... 60
Forthcoming Events ... 63
New Patents and Trademarks ... 64

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BOARD FOR MINING EXAMINATIONS :

APPOINTMENT.

Colonel the Rt. Hon. G. R. Lane Fox, M.P., Secretary for Mines, announces that he has appointed Mr. D. F. Davies to be a member of the Board for Mining Examinations vice Mr. Edmund L. Hann, resigned.

THE STRUCTURE OF AN ATOM OF NITROGEN.—VI.

By HAWKSWORTH COLLINS, B.A. (Camb.).

The following matter concerns a fifth form of nitrogen. Its relative volume is 6.53, its heat of combustion (gas) is 20500, heat of formation (gas) −20500, heat of formation (solid) −30390, magnetic rotation 1.47, and optical refractivity 2.493.

By comparing these facts with those of the four other forms already published it will be seen that the fifth form is especially distinguished from the others by its R.V. 6.53 and its M.R. 1.47.

TABLE XXXVI.

RELATIVE VOLUME OF NITROGEN (Sol. and Liq.), 6.53.

		Theor. S.G. at 15° C.	Obs. S.G.		Corresponds with
(1)	NH_3(liq.) 6.53 + 0.97 + 5.76 + 9.95	0.732	0.731	15°.5 Faraday	17, 20
(2)	NS 6.53 + 15.53	2.1	2.117	15° Michaelis	22a
(3)	$(C_2H_5)_3N$ 15.25 + 12.22 + 5.76 + 6(16.42) + 6.53	0.731	0.7317	19° Gladstone	18, 21, 28, 26

(4) $(C_3H_7)_3N$ 15.25 + 12.22 + 5.76 + 9(16.42) + 6.53	0.76	0.76	15° Perkins	24
(5) $(C_2H_5)_2NH$ 2(12.22) + 4(16.42) + 6.53 + 5.76	0.713	0.7098	19° Gladstone *i.e.*, 0.713 15°	19, 22, 27
(6) Tert. butylamine 15.25 + 4(16.42) + 2.27 + 6.53 + 9.95 + 5.76	0.692	0.693	15° Rudneff	
(7) P_3N_5 3(10.51) + 5(6.53)	2.54	2.51	18° Nostrand	22b
(8) WP_2 21.63 + 2(10.51)	5.8	5.8	Nostrand	
(9) WCl_6 21.63 + 6(15.085)	3.54	3.52		
(10) Ca_3N_2 3(14.54) + 2(6.53)	2.611	2.63	17° Nostrand	
(11) $CaCl_2$ 14.54 + 2(15.085)	2.48	2.48	Playfair	
(12) Fe_2N 6.4 + 6.94 + 6.53	6.34	6.35	Nostrand	
(13) Fe_2Si 2(6.4) + 7.13	7.0	7.0	Pick	
(14) $FeSi_2$ 6.4 + 2(7.13)	5.4	5.4	Pick	
(15) Fe_3Si_2 3(6.4) + 2(7.13)	6.7	6.7	Pick	
(16) Fe 6.94	8.07	8.007	10° Schiff	
		8.139	15°.5 Smith	

TABLE XXXVII.

HEAT OF COMBUSTION OF NITROGEN (Gas), 20500.

		Theor.	Obs.	Corresponds with
(17) NH_3 20500 + 18285 + 26375 + 27194	=	92354	90648	1, 20
(18) $(C_2H_5)_3N$ 27100 + 27853 + 26375 + 6(157787) + 20500	=	1048550	1052380	3, 21, 23, 26
(19) $(C_2H_5)_2NH$ 2(27853) + 4(157787) + 20500 + 26575	=	733729	734500	5, 22, 27

TABLE XXXVIII.

HEAT OF FORMATION OF NITROGEN (Gas), −20500.

		Calculated by H.C.	Calculated by Thomsen	Corresponds with
(20) $N.H_3$ −20500 + 16095 + 8005 + 7186	=	10786	11890	1, 17
also 3(34380) − 92354	=	10786		
(21) Triethylamine 7280 + 6527 + 8005 + 6(7391) − 20500	=	45658	42080	3, 23, 26, 18
also 15(34380) + 6(96418) − 1048550	=	45658		
(22) $(C_2H_5)_2.N.H$ 2(6527) + 4(7391) − 20500 + 8005	=	30123	29320	5, 19, 27
also 11(34380) + 4(96418) − 733729	=	30123		

TABLE XXXIX.

HEAT OF FORMATION OF NITROGEN (Solid), −30390.

		Theor.	Obs.	Corresponds with
(22A) N.S 30390 + 0.	=	− 30390	−31900	2
(22B) P_3N_5 3(23659) − 5(30390)	=	− 80973	− 81500	7

TABLE XL.

MAGNETIC ROTATION OF NITROGEN, 1.47.

		Theor.	Obs.	Corresponds with
(23) Triethylamine 0.235 + 0.265 + 0.399 + 6(1.023) + 1.47	=	8.507	8.518	3, 21, 18, 26
(24) Tripropylamine 0.235 + 0.265 + 0.399 + 9(1.023) + 1.47	=	11.576	11.610	4
(25) $C_6H_5CH_2CONH_2$ 11.016 + 1.028 + 0.633 + 0.202 + 1.47 + 2(0.399)	=	15.142	15.208	

TABLE XLI.
OPTICAL REFRACTIVITY OF NITROGEN, 2.493.

		Theor.	Obs.	Corresponds with
(26)	Triethylamine 0.985 + 1.125 + 0.82 + 6(4.6135) + 2.493	= 33.104	33.259	3, 18, 21, 23
(27)	$(C_2H_5)_2NH$ 2(1.125) + 4(4.6135) + 2.493 + 0.82	= 24.017	24.07	5, 19, 22
(28)	Isobutylamine 0.985 + 4(4.6135) + 2.493 + 1.125 + 0.82	= 23.8765	23.87	

It is not often that experimental data are given in five different directions with regard to any one substance as in the case of triethylamine, so some remarks will now be made upon this molecule. The theoretical results are in four cases out of five easily within 1 per cent. of the observed experimental data. The gaseous heat of formation, which is not so, was *calculated* by Thomsen from the heat of combustion, and he admitted that, if there is any error in the experimental H.C., the whole of this error is transferred to the calculated H.F. The discrepancy in the case of the H.C. is about 0.3 per cent., but when transferred to the much smaller number representing the H.F., it is nearly 10 per cent. It follows from this that the latter large discrepancy is of no importance at all, especially as the theoretical result has been obtained by two methods.

With regard to the theoretical results obtained for triethylamine it is necessary to remember, firstly, that whenever an atom of hydrogen is found to have a volume of 15.25, its H.C. (gas) must be 27100, its H.F. (gas) must me 7280, its M.R. 0.235, and its O.R. 0.985; and in the same way each atom of the molecule has corresponding fixed values; secondly, that the ratios of the theoretical and experimental results are

in S.G.	731	:	732
in H.C.	1049	:	1052
in M.R.	851	:	852
in O.R.	331	:	333

It is absolutely impossible for the hundreds of correspondences in all kinds of substances, which have already been published, to take place unless the truth has been obtained.

The light which has been thrown upon the structure of an atom of nitrogen by means of these hundreds of experimental facts with their corresponding hundreds of deductions cannot be fully demonstrated, until the facts with regard to the remaining two forms have been published.

For the value given for the H.F. of phosphorus in No. 22b reference must be made to the paper on this element in the *Chemical News*, 1924, cxxviii 147.

The value 11.016 for the M.R. of C_6H_6 cannot be given in more detail until there is an opportunity of demonstrating the M.R., etc., of benzene.

In No. 3 there are six groups of CH_2 and three other hydrogen atoms. These last three atoms are always given first as previously explained. The same remark applies to similar cases in other molecules.

A BRIEF REVIEW OF THE PRINCIPAL BASE METAL AND BASE MINERAL RESOURCES OF THE UNION OF SOUTH AFRICA.

By C. J. N. JOURDAN.

(Paper presented to the Empire Mining and Metallurgical Congress, Montreal, August, 1927.—Contributed by Permission of the Hon. the Minister for Mines and Industries.)

INTRODUCTORY.

The Union of South Africa is to-day probably attracting more attention than at any other period in her history—not only from tourists who are merely out for sight-seeing, but also from the business men of many countries.

The author of this paper has taken this valuable opportunity to present to the Congress of the Chemical and Metallurgical Societies of the British Empire a review of the principal base metals and minerals of the Union.

The review is perforce only a brief one. If there are any who may desire fuller information on any of the minerals treated in the review, they will be assisted by the Chairman of the Board of Trade and Industries, Union Buildings, Pretoria, South Africa.

By the Union of South Africa—or the Union as it is often abbreviated—is meant the four Provinces of the Cape of Good

Hope, Natal, Transvaal, and Orange Free State, which are situate south of Lat. 22 degrees south, and are governed by one Central Government from the Administrative Capital, Pretoria. The Union of South Africa does not include Southern Rhodesia or the Mandated Territory of South-West Africa.

The first page of modern South African mining history was written in 1863, when an English company was formed for the development of the copper mines of Namaqualand in the North-West of the Cape of Good Hope. The history since then has contained page upon page of romance equalled, perhaps, but certainly not surpassed in interest by any other country of the world.

The discovery of the first diamond in 1867 led to the opening up soon after of the wonderful diamond mines of Griqualand West in 1870 and later in the Orange Free State and the Transvaal, and still later also large tracts of land of diamond-bearing alluvial gravels.

No sooner was Kimberley developing as a diamond mining centre than stories commenced to come through of gold discoveries in the Northern and Eastern Transvaal until in 1876 the first indications of gold were observed on what has since become the world's greatest mining centre, the Witwatersrand.

Even here the romance of South African mining history did not end. At intervals important discoveries of different minerals existing in workable quantities were made until in 1924 platinum was discovered by a prospector on a farm that had received much attention in previous years while search was being made for gold and tin. This discovery led to disclosures of platinum occurrences that may prove to be of great importance in the mining development and wealth of the Union.

Still later in 1925, and, as if to prove that the old Roman adage still holds true—"Ex Africa semper aliquid novi"—there was disclosed some 145 miles west of Kimberley a most important occurrence of manganese ore that may influence greatly the future development of industry in the Union.

Whether the future will reveal as startling mineral discoveries as the past has remains to be seen. Nature has been boundlessly generous to this country. Its mineral potentialities are great and leave little doubt but that sooner or later there will be development of some of the base metals and minerals on a scale commensurate with their importance.

TOTALS OF MINERAL PRODUCTION TO DATE.

The tabular statement below indicates the total value of output of all minerals from the earliest date of existing records to 31 December, 1925. These figures are taken from the report of the Government Mining Engineer of the Union for the year 1925. At the time of writing the figures for 1926 are not yet available, but they may be taken as rather over fifty-seven millions of pounds in value. The total figure in the table of £1,225,354,232 may, therefore, be increased by that amount approximately to reveal the total value of the Union's mineral production as at the 31 December, 1926.

Gold	£876,422,756
Diamonds	244,436,960
Coal	68,739,922
Copper	24,412,180
Tin	5,414,131
Silver	3,262,408
Asbestos	1,218,632
Lead	561,135
Osmiridium ...	337,375
Soda	125,174
Corundum	116,721
Iron Pyrite ...	57,092
Zinc	50,998
Magnesite	45,865
Antimony	33,279
Graphite	27,234
Chrome Ore ...	23,955
Mica	14,748
Talc	14,214
Manganese ...	8,831
Arsenic	8,642
Iron Ore	6,433
Mineral Paints ...	6,285
Tungsten	6,149
Vanadium ...	2,716
Bismuth	300
Kaolin	144
Nickel	38
Mercury	5
Tetal	£1,225,354,232

Sundry other minerals, such as clay, stone, lime, gypsum, flint, kieselguhr, verdite, South African jade, and fertilisers or salt are not included in the above table. Figures relating to some of these are collected by the Census Office, and reliable data for others are impossible to obtain. Coal by-products are also excluded.

BRIEF REVIEW OF PRINCIPAL RESOURCES.

COAL:

With agriculture a country's resources in

coal, iron ores and oil shales form its mainstay. It is, therefore, fitting that this review should commence with a short reference to the occurrence of these minerals within the Union. ;

The coal reserves of the Union are enormous, there being available immense areas of coals of an evaporative power of 10 lbs./lb., and under, while large quantities are known to exist of an evaporative power between 10 and up to 12.5 lbs/lb., with lesser amounts of an evaporative power up to, say, 13.5 lbs./lb.

With such important resources situated within easy access by rail to coasts and ports and under ideally healthy conditions, the Union enjoys opportunity to become and remain indefinitely an important producer of coal in the Southern Hemisphere and make her competition a power in certain areas also in the Northern Hemisphere.

Less than a generation back some of the provinces which constitute the Union to-day —the Union having come into being on 31 May, 1910—imported most of their coal requirements. To-day, however, Union coals are used entirely in the industries of the whole territory, while sales for bunkering and export purposes are steadily rising, having reached 1,963,207 tons and 1,757,847 tons of 2,000 lbs. respectively for the year ending 31 December, 1925, figures that have probably been more than maintained during 1926.

The highest grades of coal that are being produced come from the Witbank area of the Transvaal and from Natal.

So far as Transvaal coals are concerned a standard has been adopted and is guaranteed, for export purposes, of an evaporative power of 12.75 lbs/lb., Delagoa Bay being the principal port of export, while it is bunkered at all South African Ports except Durban.

Grade " A " coal from the Witbank District Collieries, as supplied for export and bunkering purposes, conforms to the following analysis :—

Average of Ten Collieries—

	%
Moisture	1.02
Volatile Matter	30.63
Sulphur	1.33
Ash	11.32
Fixed Carbon	55.70
Cal. Val. Lbs./lb...	13.07

To Correct—

Lbs. per lb. to B.T.U. × .966.

Lbs. per lb. to gram calories × 536.76.

Calories to lbs. per lb. × .001863.

Coal from the Natal fields is generally classified as semi-bitumenous, and is shipped for export principally through the port of Durban, being sold in large quantities of the following approximate analysis :—

	%
Moisture	1.13
Ash	11.01
Volatile hydrocarbons	20.06
Fixed carbon	67.60
Total	100.00

Evaporative power 14.10 lbs. of water per lb. of coal. Government coal grading committees have been appointed both in the Transvaal and in Natal to administer the Coal Act of 1922, which makes among others the following provisions :

(1) No coal can be exported or bunkered unless the colliery holds a certificate specifying the grade of coal to be exported.
(2) The Committee may refuse to issue a certificate if the liability of the coal to spontaneous combustion is deemed to be a danger to life and property.
(3) The Committee may authorise its members or servants to enter at any time any colliery, storage bin, truck, vehicle or vessel or any other place where there is coal in order to sample and test such coal.

Many of the Natal coals and some of those from the Transvaal coke well, while anthracites of excellent quality are also available, in fact, the Union's present needs are met entirely from her own supplies.

Oil Shales :

Of coals of high volatile content, torbanite and oil shales, the Union has important resources. The deposits of the last-named are certainly rich enough to merit attention, and further prospecting will probably prove the fields to be larger than is at present suspected. The shales of the Ermelo District of the Transvaal are rich, and occur over a large expanse of country. Tests have yielded as much as 100 gallons of crude oil to the ton of which 3 per cent. is No. 1 petrol, and 5 per cent. No. 2 petrol, with 21 per cent. of kerosene, 23 per cent. of fuel oil, and 48 per cent. of pitch. In the Wakkerstroom District of the same Province large areas of shales have been proved which yield 30 gallons of crude oil to the ton, and such prospecting as was carried out did not prove the non-continuance of the beds.

Iron Ores :

The Union is particularly fortunate in its

possession of several important occurrences of high-grade iron ores.

The most important of these is an occurrence of haematite ore in the Rusterberg District of the Transvaal. This occurrence is fully described by Dr. P. A. Wagner in his memoir, and he speaks of it as " . . . of great purity and except for one exposure is of Bessemer grade throughout. . . ."

The following is an analysis of an outcrop of this ore taken over a width of 42 feet by the writer :

	%
SiO_2	3.35
TiO_2	Nil.
Al_2O_3	0.50
FeO	95.80
S	Nil.
P_2O_5	0.05
V_2O_5	Nil.
Loss on ignition	0.27
Total	99.97
Fe	66.23
P	0.05

The following partial analyses of samples of the ore body from different localities are taken from Dr. Wagner's memoir, and are of great interest as showing the uniformly excellent quality of the ore :—

	Fe	SiO_2	P
1.	65.00	2.28	0.03
2.	67.40	1.08	0.05
3.	67.75	1.60	0.01
4.	54.20	3.02	0.01
5.	64.58	0.89	0.008
6.	65.05	2.40	0.01

On the town lands of Pretoria there is also an important occurrence of iron ore where there are two distinct iron-bearing formations known as the " clay-band " and " magnetic quartzite " respectively and complying with the following analyses :—

	Magnetic Quartzite. 1.	2.	Clayband
SiO_2	17.44	18.80	7.70
TiO_2	Trace	—	—
Fe_2O_3	68.11	68.89	73.57
FeO	1.32	4.81	—
Al_2O_3	7.38	4.48	7.94
CaO	0.75	—	0.45
MgO	0.47	0.22	0.33
P_2O_5	0.39	0.398	1.19
Loss on ignition......	4.30	3.92	8.60
Totals ...	100.16	99.43	99.78

	Magnetic Quartzite. 1.	2.	Clayband
	%	%	%
Fe	48.60	50.10	51.50
P	0.17	0.17	0.52
S	0.104	0.01	0.021

It has been demonstrated on commercial lines that a grey iron of good quality can be produced by a mixture in correct proportion of " magnetic quartzites " and the " clay-band " ore useing either limestone or dolomite as flux and South African coke as feul. The reserves of iron ore in these developments in the Pretoria geological series run into immense tonnages.

Yet other important occurrences of iron are haematite in felsites some 45 miles north-east of Pretoria, the deposits in the Karroo geological system near Ermelo in the Transvaal, near Dundee and Newcastle in Natal—where pig iron is to-day actually being produced—and on Klipfontein, near Postmasburg, some 145 miles west of Kimberley.

Situate within reasonable distance of her iron and coal deposits the Union is possessed of important occurrences of chromite, dolomite, fluorspar, limestone, magnesite, manganese, nickel, tungsten, and vanadium, while indications are not wanting to point to possible occurrences also of cobalt and molybdenum, all essential minerals to a self-contained and complete iron and steel industry.

By its declaration in the Governor-General's speech at the opening of the present session of the Union Parliament the Government has expressed its confidence in the future of a South African iron and steel industry. Legisation giving effect to the Government's intentions is before Parliament in its present session.

The successful launching of this key industry—and there would seem to be no technical reasons why it should not be successful—should mark the commencement of a new era in the history of the Union—the era of industrial development.

(*To be continued.*)

COLOUR USERS' ASSOCIATION DIARY.

This Association issues a neat and handy pocket diary, which, besides the usual diary features, contains a mass of useful information for those connected with the dye and colour industry. The headquarters of the Association are at Cromwell Buildings, Blackfriars Street, Manchester, and it offers a high standard of service to its members.

GENERAL NOTES.

THE INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

JANUARY EXAMINATIONS, 1928.
PASS LIST.

Examination in General Chemistry for the Associateship.

Boudry, Cyril, B.Sc (Lond.)—Rutherford Technical College, Newcastle-on-tyne, and Central Technical College, Birmingham; Chanmugam, Walter Raju—Chelsea Polytechnic, London; Cooksey, Arnold, B.Sc. (Lond.)—Wigan and District Mining and Technical College; Lockwood Harold Claude, B.Sc. (Lond.)—Central Technical College, Birmingham; Lucas, Charles Edward Leslie—Royal College of Science, London; Maddocks, Charles Bernard—University College, Nottingham; Pritchett, Eric George Kemp, B.Sc. (Lond.)—Central Technical College, Birmingham; Rhead, Alfred James—Central Technical School, Liverpool; Smith, Walter—Heriot-Watt College, Edinburgh.

Examination for the Fellowship in The Chemistry and Microscopy of Food and Drugs, held in New Zealand in November, 1927.

Gardner, Roy, M.Sc. (N.Z.).

WHOLESALE PRICES IN 1927.

BOARD OF TRADE INDEX NUMBER.

As measured at the Board of Trade, wholesale prices were lower, on the average, by about 4½ per cent. in 1927 as compared with 1926, and about 11 per cent. as compared with 1925; the index numbers for the three years were 85.1, 89.1 and 95.7 respectively (1924 = 100). The index for food fell from 93.2 in December, 1926, to 90.8 a year later, the meat and fish group showing a fall from 99.6 to 91.2, while cereals and the "other foods" included in Group III., became slighty dearer. Industrial materials declined by nearly 6 per cent., on the average, in 1927, the index numbers for each of the five groups showing a lower average for 1927 than a year earlier. The greater part of this decline was accounted for by the drop of nearly 19 per cent. in the "other metals and minerals" group, which includes coal. The index for this group prior to the national coal-stoppage was 90.0 in April, 1926, and after the resumption of normal conditions in the coal industry the index figure for the group declined from 87.5 in April, 1927, to 79.1 in December. The average for iron and steel was lower by about 3 per cent. in 1927 as compared with 1926 prices, while a corresponding comparison in the cases of "textiles, other than cotton," and "other miscellaneous industrial materials" shows relative decreases of 2.4 and 1.7 per cent. respectively. Although the 1927 average index number for cotton was about 2.2 per cent. lower than that for 1926, actually the index number for this commodity rose from 58.9 in January, 1927, to 70.9 in December, with a highest monthly index of 78.0 in September.

The index number for all articles showed a fall of about ½ per cent. in December, 1927, as compared with November, and a fall of a little under 4 per cent. as compared with a year earlier.

OIL-SHALE DEVELOPMENTS IN NEW BRUNSWICK.

According to the "Canadian Mining and Metallurgical Bulletin," the oil-shale plant of the Maritime Education Company, at Rosevale, some twenty miles south-west of Moncton, Albert County, is now nearing completion and it is expected that in the course of a few weeks work will be started on the extraction of oil from the small mountain of oil-shale at its back.

ROYAL SOCIETY OF ARTS.

John Street, Adelphi, London, W.C.2.

COMPETITION OF INDUSTRIAL DESIGNS, 1928.

Particulars of the Fifth Annual Competition of Industrial Designs to be held at the Imperial Institute, South Kensington, London, S.W., in June, 1928, have now been issued, and can be obtained from the Secretary of the Royal Society of Arts, John Street, Adelphi, London, W.C.2. Intending competitors must apply to the Secretary of the Society between May 1 and May 12 for the necessary entry forms. In all, Scholarships and Prizes amounting to nearly £1,600 are offered in connection with the 1928 Competition.

The Empire Marketing Board are offering in connection with this Competition three prizes for a design in four colours for a shop window bill, with the lettering "Buy Empire Produce from Home and Overseas." The Royal Society of Arts offers a Prize of £50 for designs for an entrance hall to a cinema, and a Prize of £25 for a design for a silver cup for the Swiney Prize for the best published work on Jurisprudence. Four

Scholarships will also be awarded—the James Hyde Scholarship of £100 for architectural designs for Textiles; one of £75 for designs for printed and woven dress goods and printed furnishings offered by the Tootal Broadhurst Lee Company; the Lewis Berger Scholarship of £60, open to Apprentices, Students or Craftsmen in the Craft of Painting and Decorating; and the Art Congress Studentship of £50 for practising Craftsmen or Designers, founded by the late Sir William Cuthbert Quilter.

Valuable Prizes ranging from £5 to £52 10s., are also offered as under:—

In the Architectural Decoration Section for designs for a wrought-iron canopy for the entrance to a theatre, a decorative fountain, a petrol-filling station, and a bathroom.

In the Textile Section for designs for cretonnes, axminster carpets, printed linens, machine-made lace, hand embroidery, silk fabrics for furniture and decoration, and wallpaper.

In the Furniture Section for dining, drawing and bedroom furniture, dining chairs, wireless cabinets, and panels for a baby carriage.

In the Book Production Section for pages of text, title page, contents page, head and tail pieces, end papers, jacket and binding case.

In the Pottery and Glass Section for china cup, saucer, cream jug, bread and butter plate, and teapot, eartherware dinner plate and vegetable dish, service of glass, and a cut centrepiece with vases to match.

In the Miscellaneous Section for designs for posters and showcards for textile fabrics, motor oil and tyres, cocoa and Easter eggs, infants' food, and an electric wiring system, and for designs for Christmas cards and calendars, bookmarks, booklet cover, and a window display piece.

The Royal Society of Arts was founded in 1754 for "The Encouragement of the Arts, Manufactures and Commerce of the Country," and it is interesting to remember that it was this Society's offer of prizes in 1846 for "useful objects calculated to improve general taste," which led to the holding of the Great Exhibition of 1851 and to the commencement of the present school of Art-Workmanship in the British Empire.

UNITED STATES OF AMERICA.

National Wealth and Industrial Conditions.

The substantial character of the general prosperity prevailing in the United States and the rapidity with which the present level of well-being has been attained are strikingly indicated by current authoritative estimates of the country's wealth and the income of its population, writes Sir J. Joyce Broderick, K.B.E., C.M.G., British Commercial Counsellor at Washington, in his joint Report (with Captain A. J. Pack, Commercial Secretary), on Economic Conditions in the United States of America (dated May-June, 1927). According to the calculations of the Bureau of the Census, the total national *wealth* (comprising real property, industrial and agricultural plant and equipment, railways and other transportation systems and their equipment, communication systems, shipping and canals, irrigation enterprises, light and power stations, agricultural, industrial and mining products, imported merchandise, personal and household furnishings, etc.) amounted in the year 1900 to a little over 88,000 million dollars, and had grown, by 1925, to about 355,000 million dollars, or from about 1,100 dollars to more than 3,000 per head of the population.

In the last twenty-six years the annual income, representing values created each year—the aggregate of all goods and services produced—by the labour of the American people, grew, according to this authority, from some 18,000 million dollars to nearly 90,000 million dollars, or from 236 dollars, to about 770 dollars per head. Another authority, the National Industrial Conference Board, widely recognised for its careful research work, gives a more conservative estimate based upon growth of production rather than on money incomes.

It is well to dispel the impression which appears to be fairly widespread in Great Britain to the effect that American employers worked out a philosophy of high wages and embarked upon a settled policy of increasing wage rates with the conscious object of augmenting the purchasing power of the working population.

Agricultural purchasing power next comes into purview, and business profits are gauged and discussed. The steady fall in commodity prices since September, 1925, is examined, figures of the growth in national savings are given, and the export of American capital and the tariff question are touched upon.

Recent Trends in Basic Industries and Trade.

In Section II. of their Report the authors emphasise the importance of well-balanced prosperity in the United States. For causes too obvious to need detailed repetition, they state in their remarks introduc-

tory to the section, the people of other countries are scarcely less concerned than the people of the United States with the continuation of a well-balanced prosperity on this Continent. Depression in America, or even a serious halt in American industrial activity, would create now much more surely than in earlier periods a disturbance the consequences of which would be immediately and widely felt abroad. The great value of American surplus capital in furthering reconstruction, bringing about stabilisation and restoring industry in foreign nations, has been already indirectly referred to. This country's large purchases of foreign commodities have been no less important. Her active automobile and rubber manufacturing industries, for example, were responsible last year for the importation of 500 million dollars' worth of crude rubber from British and other producing territories. Her imports of raw silk were valued at close on 400 million dollars, of coffee at 323 million dollars, of cane sugar, at 233 million dollars, of wool at 107 million dollars., of pig tin at 105 million dollars, and so on through a long list of raw materials and foodstuffs on the sales of which the well-being of large populations elsewhere is based.

A decline in her manufacturing or consuming energies would greatly reduce her need for these foreign commodities and diminish also her imports, over the tariff wall, of manufactured and partly manufactnred articles which, in 1925, were valued, in round figures, at over 1,900 million dollars. The character of her export trade also depends largely upon the fluctuation in demand for goods on her domestic market, and American competition in foreign countries is likely to be more reasonable and healthy when it rests on comparative quality and price of the goods offered than if it should represent, even temporarily, an effort to dispose, at unduly reduced prices, of surpluses unsaleable at home. For these and other reasons the writers outline in this chapter the current position and apparent prospects of the principal branches of industry and trade—agriculture, building, automobile industries, iron and steel, petroleum, textiles, etc.—that have, in the past few years, contributed most to the general activity or held it somewhat n check.

In a general summary concluding the chapter the authors say that a noticeable decline is taking place in general industrial and commercial activity from the high levels attained last year and in the early months of the present year. Notwithstanding an encouraging rise in the prices of some agricultural commodities, there is still a wide margin between general agricultural and general industrial prices, and the position of some sections of the farming community, which has been a weak link in the chain of general prosperity, continues to be unsettled and uncertain.

The volume of building construction, which for several years provided an extraordinarily solid and steady support for general business, is showing a lag, particularly in the centres where it has been largest. Offsets in other sections and in the reconstruction of the flooded Mississippi valley are hardly likely to compensate for the reduced volume of building in New York, New Jersey, etc. The position in the automobile manufacturing industry, another prop of general activity, is mixed, a few manufacturers having gained ground in a severe competition and many more having lost it, with the general result of somewhat curtailed total output.

The iron and steel industries, after a very active period early in the year, have slowed down to a notable degree, with forward orders lower than they have been for a long time past and prices at unprofitable levels. The soft coal mining industry is in the throes of a costly strike. The petroleum industry is in a critical state owing to overproduction and congestion of crude oil and gasoline. Over-production also hampers the woollen and silk textile industries.

A superabundance of investment funds based, in the last analysis, on a large supply and continued influx of gold, has produced inflation in the securities market. With the notable exception of one or two branches of industry and a few individual concerns, the profits of industrial corporations, even some of the strongest and most efficient, have been reduced (by keen mutual competition, high wages, largely developed producing capacity, and a declining tendency of wholesale prices) to very narrow margins. Foreseeing a still more severe struggle for markets and with no great prospect of curtailing producing costs much further by improved mechanical equipment, many manufacturers are beginning to turn an inquiring eye on the high levels of industrial wages, and a prolonged lag in activity would undoubtedly give rise to a vigorous canvassing of the possibility of a general wage deflation.

The costs of distribution, generally speaking, are very high, and there is a noticeable lack of correspondence in many lines between wholesale and retail prices,

The instalment purchasing system has apparently reached a point whence it cannot be much further expanded with safety.

All the foregoing are unfavourable factors, and if contemplated alone might suggest to anyone unfamiliar with the elasticity of American conditions that the end of the golden era had arrived, and that the country was facing a drastic decline in prosperity; but they are offset and diluted to a great degree by factors on the other side of the balance. In the first place, the late spring and summer months, even in the best of years, are marked by some contraction in general activity, induced, no doubt, by the uncertainty then prevailing respecting the estimated outturn of the crops and the probable purchasing power of the agricultural regions that form so important a proportion of the market for the nation's industrial production. Considering the extraordinary pace set by business and industry during the last few years, a lull is scarcely surprising, and may probably exercise a restraining influence that will avert bad consequences later on.

The credit situation is particularly strong. Funds are available in ample measure on easy terms to finance all the needs of business and industry. Their superabundance is indicated by the situation in the stock market. The large gold supply furnishes a further insurance against stringency, which lay at the root of most of the heavy business depressions that occurred in the past history of the country. Stocks of manufactured products are low, and such as there are, outside the petroleum industry, can be carried at a very reasonable cost. Wages remain high; employment in general continues good, and the purchasing power of the industrial community is scarcely impaired. Retail trade is proceeding in good volume. Railway freight traffic is well maintained. Foreign trade is flourishing.

Viewed as a whole, general business conditions of the United States at the present time, though somewhat less prosperity than last year or the year before and undergoing a shaking down process—a further adjustment of production to current needs—reveal no very seriously unhealthy indications. These observations apply to the country as a whole. In the different geographical sections conditions vary according to the importance and fortunes of the main industries. In certain agricultural regions the situation is not so good. In the cotton belt regions the prospects are improving, though the position is still suffering from the adverse effects of unprofitable returns on last year's cotton crop. Improvement is notable also in the New England States, which have hitherto not enjoyed a large share of the general prosperity.

From the British point of view the New England States are of particular interest because the situation there has borne, and still bears, a closer resemblance than that in any other region on the American Continent to the changing system in Great Britain. The cradle of the factory system in America, with its factory sites determined by the situation of the waterfalls that furnished them with power, and necessarily without reference to many of the factors that promote producing and distributing efficiency under present conditions in the United States, with its labour system and methods recruited and shaped, through a long history, on lines not too dissimilar from those of Britain, with heavy investments in obsolete or obsolescent plants, with all the other handicaps as well as the advantages of early industrial and commercial developments, New England, as one of her business leaders points out, has been faced with problems rather different from those arising among American industries in other sections. She has had hard times, serious labour troubles, and difficult adjustments. Many of her manufacturing enterprises have migrated to other parts, and many of her long-established firms have been driven into liquidation by the competition of the younger and more modern concerns that sprang up in better strategic positions elsewhere in the country. Now, however, New England seems to have overcome her worst difficulties. It is noteworthy that in spite of them her population has gained by about 10 per cent. in six years, and that with but 7 per cent. of the population of the country she is now turning out more than 11 per cent. of the country's manufactured products.

ROYAL INSTITUTE OF PUBLIC HEALTH.

CONGRESS IN THE CITY OF DUBLIN, AUGUST 15-20, 1928.

The next Congress of the Royal Institute of Public Health will be held in the City of Dublin from Wednesday, August 15, to Monday, August 20, 1928, on the invitation of the Government of The Irish Free State, together with the cordial support of the University of Dublin, The National University of Ireland, The Royal Colleges of

Physicians and Surgeons of Ireland, and the Apothecaries' Hall or Ireland.

The Council, in accepting this invitation, trust that it will be an encouragement to the Government of the Irish Free State in the various measures now being considered with the object of placing the public Health interests of the community on a good progressive basis, as well as to those entrusted with executive duties.

The Congress will be conducted in the following sections :—

Section I.—" State Medicine " (a) Municipal County and Port Sanitary; (b) Epidemiology: (c) Tuberculosis; (d) Housing of the Working Classes, and Town Planning.

Section II.—" Bacteriology, Pathology, and Biochemistry."

Section III.—" Maternity and Child Welfare, and School Medical Inspection.' '

Section IV.—" Production and Control of Milk and Food."

To this Congress delegates are being invited from the Governments, the Municipalities, and other public bodies and Universities of England, Scotland and Ireland, as well as from France, Belgium, Italy, The United States of America, etc.

It will be noted that this Congress will be held subsequent to the Dublin Horse Show.

The Hon. President of the Congress will be His Excellency, the Governor-General of the Irish Free State, and the President will be the Minister for Local Government and Public Health, Dublin.

Proceedings and Notices of Societies.

THE CHEMICAL SOCIETY.

Papers read on Thursday, January 19—

CycloTelluropentane. By G. T. MORGAN AND H. BURGESS.

*cyclo*Telluropentane, the parent telluro-hydrocarbon of the *cyclo*telluripentane-3 :5-dione-1 : 1-dichlorides and *cyclo*telluropentane-3 : 5-diones, has now been prepared by a series of reactions in which the starting materials are αε-pentamethylenedihalides and a metallic telluride, preferably aluminium telluride.

*Cyclo*Telluripentane-1 : 1-di-iodide exists in two differently coloured modifications (*a*) deep red, with purple blue reflex, stable at the ordinary temperature, (*b*) orange, stable only at higher temperatures. In these colour changes *cyclo*telluripentane-1 : 1-di-iodide closely resembles mercuric iodide.

Syntheses of Cyclic Compounds. Racemic and Mesoethyl βγ-diphenylbutane-ααδδ-tetracarboxylate. Synthesis of a Truxinic Acid. By I. VOGEL.

The reduction of ethyl benzylidenemalonate with moist aluminium amalgam in ether gave ethyl benzylmalonate and a mixture of *meso-* and r-*ethyl βγ-diphenylbutane-ααδδ-tetracarboxylates.* The meso-ester on treatment with sodium methoxide in ethereal solution, followed by bromine, hydrolysis and heating at 280° gave a very poor yield of a *βγ-diphenylcyclobutane-αδ-dicarboxylic acid*, m.p. 209° (dimethylester

$$\begin{array}{l} PhCH\cdot CH.CO_2H \\ PhCH-CH.CO_2H \end{array}$$

m.p. 127°), which appears to be identical with Stoermer and Bachér's *neo*truxinic acid (*Ber.*, 1925, LV, 1865), whilst the *r*-ester on treatment with sodium methoxide and then bromine gave a practically quantitative yield of r-*ethyl-αδ-dibromo-βγ-diphenylbutane-ααδδ-tetracarboxylate.* The bearing of these results on the Thorpe-Ingold modified strain theory as well as the mechanism of the reduction of unsaturated compounds by moist aluminium amalgam in ether is discussed.

Properties of Conjugated Compounds. The Formation of Isomeric Additive Dibromides from Butadiene. By E. H. FARMER, C. D. LAWRENCE, AND J. F. THORPE.

It has been sought by re-examining the formation and properties of butadiene dibromides to gain further information as to the primary or secondary nature of the products occurring in the bromination mixture and therefore as to the validity of the modern extension (electronic) of Thiele's hypothesis.

Butadiene yielded with bromine under all conditions employed both 1 :2- and 1 :4-dibromides. These bromides were readily interconvertible at 100°, each form tending to yield an equilibrium mixture of both forms; at lower temperatures isomerisation took place much less rapidly. The proportion of isomerides in the bromination mixture could be considerably altered by varying the experimental conditions, and the production of the 1 : 4 compound entirely suppressed by substituting quinoline perbromide for bromine.

Experiments were carried out to distinguish between the specific effect of the solvent on the composition of the bromination mixture and that due to hydrogen bromide, moisture, etc. Whilst it has been impossible to correlate the extensive production

of the 1 : 4-dibromide from butadiene with the speed, under comparable conditions, of the 1 :2—>1 : 4-change, the factors which determine the appearance of both types of dibromide appear to involve more than the mere co-existence of two activated forms of the conjugated hydrocarbon. This question is discussed.

THE ACTION OF NITROUS ACID ON WOOL FIBRE.

By H. I. Waterman and J. Groot.

The authors have made a further study of the problem of what happens when wool is treated with nitrous acid. It was found that diazotising and boiling the wool caused practically no decrease in the amount of nitrogen. This may be adduced as an argument against the assumption of the formation of a true diazo-compound on the fibre. An experiment made to ascertain whether, after the action of HNO_2 on wool, as many gr. mols. of H-acid are bound as nitrogen escapes during the boiling, showed that considerably more H-acid is removed from the bath, probably due to adsorption by the fibre.

By making several repetitions of the process of diazotising and boiling we found that the wool fibre was able to produce colouring matter with azo-components each time it had been treated with nitrous acid.

With the kind of wool used, the usual method of diazotisation yielded about 0.2 per cent. N_2 during boiling. A prolongation of the action raised this percentage and an increase in HNO_2 concentration had the same effect. The question as to whether nitrous acid which might possibly be absorbed by the fibre, plays any part in the formation of the dyestuff, has not been definitely settled, nor has it been ascertained whether tyrosine is an essential component of the said formation.

Whilst undyed wool becomes luminous if exposed to ultra-violet rays, it appears to lose this faculty owing to the formation of colouring matter in the way described or, in fact, already in the earlier stage of the treatment with HNO_2.—*Abstracted from Chemisch Weekblad*, 1928, xxv, 18.)

NOTICES OF BOOKS.

Alchemical Researches. By F. Jollivet Castelot. *Chimie et Alchimie, Etudes d'Hyperchimie* par F. Jollivet Castelot. Pp. 288. Paris : Emile Noury, 62, Rue des Ecoles. 1928. Price 15 francs.

The acquisition of riches surpassing the dreams of avarice and the prolongation of life were the prizes sought by the mediæval alchemists, many of whom spent a lifetime and a fortune in search of the Philosopher's Stone, which was to bring about these objects. The chemical discoveries of the nineteenth century and the introduction of mathematics to the interpretation of chemical and physical phenomena discredited the attempts to transmute mercury and other metals into gold.

Since it has been shown that lead and the inert gases are produced by the disintegration of uranium, radium and thorium, there has been a revival of interest in alchemy, although M. Jollivet Castelot intimates that his work has been ignored in scientific circles.

Observed disintegration has been followed by attempts to degrade lead and mercury. Thus Miethe and Stammreich, and Nagaoka claimed to have transmuted mercury into gold by electrical means, but his own experiments followed those of Tiffereau, a Frenchman, who claimed to have transmuted a silver-copper alloy into gold by nitric acid treatment and exposure to sunlight in Mexico.

M. Jollivet Castelot, who also quotes Strindberg's film experiments, has similarly worked at the problem since 1892. In a typical experiment he mixed pure silver with the sulphides of arsenic and antimony and fused for one hour with potassium cyanide. The residue, on cupellation, was golden and nitric acid acted on it with difficulty. The solution after evaporation showed an absence of Ag, As and Sb, but answered positive tests for gold. Other transmutations are cited and the author states (p. 174) " La transmutation de l'argent en or, la fabrication artificielle de l'or est donc une chose aujourd'hui nettement établie et dont il est facile de tirer les importantes consequences."

It is suggested that transmutation is effected by a " mineral ferment,' *i.e.*, a catalyst like manganese dioxide or finely divided platinum.

The present volume is not confined to these recent repetitions of the mediæval adepts, but deals also with Hermetic Philosophy, and the Philosopher's Stone, and gives a *résumé* of early and mediæval alchemy. Special importance is accorded to the works of Thomas Vaughan and it is thus a little surprising that the bibliography omits any reference to the important works of Redgrove and especially of Waite (see *The Chemical News*, 1927, cxxxv, 125; 1924, cxxviii, 418; 1922, cxxv, 383; cxxiv, 194.)

The book also contains one or two errors. Thus, Kremnitz is a gold-producing town in Czechoslovakia, not Hungary, as stated on p. 167. These, however, scarcely detract from the value of M. Jollivet Castelot's interesting work.

J. G. F. DRUCE.

Lehrbuch der Thermostatik. By PROF. J. D. VAN DER WAALS. Revised by PROF. P. KOHNSTAMM. Pp. VIII + 402. Leipzig: J. A. Barth. 1927. Price 22 marks.

The first section of the present part of Dr. Kohnstamm's revised version of van der Waals' *Thermodynamics* deals with the analytical considerations of the conditions of equivalence, the connection between the concentration of gaseous and liquid phases and between vapour pressure and liquid concentration.

The properties of binary mixtures at the critical points and the systems with two liquid phases are discussed at length. Miscibility factors, the co-existence of liquid and solid phases, the crystallisation of solids from binary mixtures, the crystallisation of pure components and other questions relating to the study of binary mixtures are also discussed.

Das Gesetz der Chemischen Massenwirkung. By PROF. RICHARD LORENZ. Pp. x + 176. Leipzig: Leopold Voss. 1927. Price 12 marks 50 pf.

Prof. Lorenz traces the latest extensions of the Law of Mass action and its thermodynamical basis from its original classical outline by Gibbs to the most recent knowledge on displacement phenomena. Among the examples given of the classical law are the dissociation of HI, the hydrolysis of esters, and the coefficients of partition of succinic acid between water and other solvents.

The limitations of the classical theory and the consideration of thermodynamical functions have lead to the enunciation of an Ideal Law of Mass Action for the case of a system of four substances which exist in two phases, *e.g.*,

$$Pb + CdCl_2 \rightleftarrows Cd + PbCl_2$$

The author applies this Ideal Law to condensed systems and discusses its further applications. He also deals with the theory of alloy which he put forward, in conjunction with Prof. van Laar ,in 1926.

The volume should prove of special interest to students of physical chemistry.

Physikalisch-chemische Ubung. By PROF. W. A. ROTH. Fourth Edition, pp. VIII + 316. Leipzig: Leopold Voss. 1928. Price 13 marks.

The third edition (1921) of Prof. Roth's widely used *Practical Physical Chemistry* was practically a photo-mechanical reproduction of the second. The latest issue is, however, a completely revised one and presents the subject with the most recent additions and improvements in the methods of physical chemistry. It follows, in the main, the lines of English University Courses in the subject with perhaps, some extensions as, for instance, in thermochemistry. The work is assured of a large number of readers and can be recommended to English students who wish to improve their knowledge of German.

Quantitative Analyse durch Elektrolyse. By PROF. A. CLASSEN AND DR. H. DANNEEL. Seventh edition. Pp. x + 400. Berlin: Julius Springer. 1927. Price 22 m. 50 pf.

The electrolytic estimation of metals is coming more and more into general use because of their accuracy, rapidity and simplicity. The pioneer work of Prof. Classen in this field is well known and his collaborator has been to much trouble to collect the latest details of new methods and technique so that the seventh edition will be, like its predecessors, the standard work on the subject. Overvoltage and other phenomena are also discussed at the end.

Die Katalytischen Wirkungen der Lebendigen Substanz. By PROF. O. WARBURG. Pp. VIII + 528. Berlin: Julius Springer. 1928. Price 36 marks.

This important work merits the careful attention of biochemists, physiologists and the medical profession. The first section consists of a series of papers on respiration and fermentation processes. The second deals exhaustively with the assimilation of carbon and nitrogen, and the third with catalytical actions in growing cells.

The assimilation researches were conducted with a microscopic green alga, *Chlorella,* which was grown in a culture solution of $NaNO_3$, $MgSO$, and KH_2PO_4 through which air and carbon dioxide were bubbled. Many observations were made and compared with those of Blackman, Willstatter, and other workers in this field. Prof. Warburg's conclusions, undoubtedly important, do not lend themselves to summarisation, but it may be mentioned that he has shown, *inter alia,* the parallelism between the action of HCN and substituted urethenes on the decomposition of CO_2 by chlorella and on the decomposition of H_2O_2.

J. G. F. DRUCE.

Annual Survey of American Chemistry. Vol. II. July 1, 1926, to July 1, 1927. Edited by CLARENCE J. WEST, and published for the National Research Council by the Chemical Catalog Company, Inc., 419, Fourth Avenue, New York, N.Y., U.S.A.

This is an authoritative publication which is published under the auspices of the Division of Chemistry and Chemical Technology. It extends to 414 pages, and is published at the modest price of 8 dollars. There are some four dozen contributors, and their combined efforts have resulted in a work replete with interesting and up-to-date information, and we are sure that the good reception extended to Volume I of the Survey will be repeated in this instance. The chapters, which are 49 in number, deal with subjects of interest and importance that have been prominently before the scientific public during the period covered by the review. The various contributors are liberal in the bibliography, so that readers wishing for fuller facts than could be published in the volume before us can easily consult the pages of the publications in which the subjects referred to were expounded at length. The present useful book can be obtained in London from Mr. Arthur F. Bird, 22, Bedford Street, Strand, W.C.2.

Acetate Silk and Its Dyes. By CHAS. E. MULLIN, M.Sc. With a Foreword by LOUIS A. OLNEY, D.Sc. (President of the American Association of Textile Chemists and Colourists. Pp. 474. Price 26s. net. London: Constable and Co., Ltd., 10-12, Orange Street, W.C.2.

Silk, artificial silk and dyes play such a large and important part in the trade, commerce and prosperity of the world that no apology is needed for the publication of an authoritative work on any branch of the subject. The author of the present work had a good subject and he has produced a book which will be read with interest. During the past few years a number of articles on acetate silk and its dyes have appeared in American and Canadian publications, and the author seems to have made good use of the information contained in them. He has gathered into one volume practically all the important information about the subject and given it in very readable form, handy for reference and study for those specially interested in the subject, and interesting for the general reader who wishes to keep up-to-date in his knowledge of a steadily developing industry.

Qualitative Analysis. By WILLIAM WARDLAW, D.Sc. (Dunelm), F.I.C., AND FREDERICK WILLIAM PINHARD, M.Sc. (Wales), A.I.C. Pp. 166. Price 3s. 6d. London: Longmans, Green and Co., Ltd., 39, Paternoster Row.

The present work, while perforce not exhaustive, will at the same time prove serviceable to students and others, as it contains really important matter, and the authors have been discreetly brief in dealing with things which they deemed less important, devoting the space thus made available to essentials. The work, which is modest in price, will meet the requirements of many, better than larger and more pretentious and expensive works. The analytical tables have been rendered more valuable because of the explanatory notes attached thereto. It is a neat and useful volume, which ought to have a good sale.

FORTHCOMING EVENTS.

OIL AND COLOUR CHEMISTS' ASSOCIATION.

At Painters' Hall, Little Trinity Street, London, E.C.4.

Wednesday, February 1.—"The Painting of Cement and Plaster." Joint discussion with the Incorporated Institute of British Decorators.

PEOPLE'S LEAGUE OF HEALTH.

At Lecture Room of the Medical Society of London, 11, Chandos Place, Cavendish Sq., London, W.1.

Thursday, February 2.—"Primitive Instinct." By E. D. Macnamara, F.R.C.P.

ROYAL INSTITUTION.

21, Albemarle Street, London, W.1

Tuesday, January 31, at 5.15 p.m.—Prof. A. P. Newton: "The Mercantile Empire, 1606-1783."

Thursday, February 2, at 5.15 p.m.—Sir William Bragg: "From Faraday's Note Books."

Friday, February 3, at 9 p.m.—Prof. E. C C. Baly: "Photo-synthesis."

Saturday, February 4, at 3 p.m.—Mr. H. C. Colles: "Musical London (1660-1759)."

ROYAL INSTITUTE OF PUBLIC HEALTH.

37, Russell Square, London.

Wednesday, February 1, at 4.30 p.m.—"Medico-Legal Problems of Lunacy." By Nathan Raw, C.M.G., M.D., F.R.C.S, Ed.

ROYAL SOCIETY OF ARTS.

John Street, Adelphi, London, W.C.2.

Monday, January 30, at 8 p.m.—Cantor Lecture by Albert Ernest Dunston, D.Sc., F.I.C.

Tuesday, January 31, at 4.30 p.m—(Dominions and Colonies Meeting). "Migration in the Empire." By the Rt. Hon. Lord Lovat, K.T.

Wednesday, February 1, at 8 p.m.—"Modern Aspects of Rubber Cultivation." By Charles Herbert Wright, B.A.

SOCIETY OF CHEMICAL INDUSTRY.

Manchester Section. Friday, February 3.—"The Influence of Zinc Oxide on the Coefficient of Vulcanisation." By S. A. Brazier, M.Sc., F.I.C., and L. R. Ridgway, Ph.D. M.Sc., A.I.C.

SOCIETY OF PUBLIC ANALYSTS.

Burlington House, London, W.1.

Wednesday, February 1, at 8 p.m.—"The Determination of Butter in Margarine." By L. V. Cocks, A.I.C., and E. Nightingale. "The Deposition of Metals on Copper from Cyanide Solution. I. A New Method for the Separation and Determination of Small Amounts of Lead." By B. S. Evans, M.C., Ph.D., F.I.C. "Investigations into the Analytical Chemistry of Tantalum, Niobium and their Mineral Associates. X. The Separation of Silica from the Earth Acids. XI. The Precipitation of Titanium by Tannin." By W. R. Schoeller, Ph.D., and A. R. Powell. "The Determination of Carvone in Dill Oil." By Prof. Joseph Reilly, D.Sc., F.I.C.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, Victoria Embankment, London.

Thursday, February 2.

THE ROYAL SOCIETY.

February 2, at 4.30 p.m.

UNIVERSITY OF LONDON.

University College, Gower Street.

Monday, January 30, at 2 p.m.—"The Northern Epic." Public Lecture by Prof. R. W. Chambers, F.B.A.

Wednesday, February 1, at 5.30 p.m.—"The Provision of Commercial and Technical Literature in the Smaller Public Libraries." Public lecture by Mr. Charles Nowell, F.L.A., City Librarian, Coventry.

At 6 p.m. — Newmarch Lectures :— "Measurement by Index Numbers." By A. L. Bowley, Sc.D., F.B.A. (Other lectures, February 8, 15, 22, 29 and March 7.)

Thursday February 2. at 5.30 p.m. "The Carbonari." Public lecture by Prof. Edmund G. Gardner, F.B.A.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

526.—Chemische Fabrik vorm. Sandoz. Acridine derivatives. January 6th.

214.—Hooley, L. J.—Manufacture of derivatives of benzene, etc. January 3rd.

56.—I. G. Farbenindustrie Akt.-Ges.—Production of acetaldehyde. January 2nd.

180.—I. G. Farbenindustrie Akt.-Ges.—Manufacture of methylene chloride. January 3rd.

488.—I. G. Farbenindustrie Akt.-Ges.—Manufacture of 2 amino-3-carboxylic acid, etc. January 6th.

Specifications Published.

282,853—Soc. of Chemical Industry in Basle.—Maunfacture of anthraquinone derivatives.

282,907.—Tcherniac, J.—Manufacture of ortho-anisidine and similar aminophenol ethers.

282,917.—Barbet, E. A.—Process for the *utilisation of alcoholic fermentation*

in order to form large quantities of glycerine by the use of sulphurous acid.

282,947.—Sebrell, L. B., and Teppema, J. —Method of preparing mercantothiazoles.

260,000.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of anthracene derivatives and of benzanthrene.

Abstract Published.

280,763.—Phosphoric acid.—Urbain, E., 6, Rue Lyautey, Paris.

Phosphorus; cements; materials for making gas.—In the process of preparing phosphorus by heating together calcium triphosphate, silica and carbonaceous substances, a portion of the silica is replaced by alumina or clay to obtain a fusible slag having the composition of an alumina cement. The vapours evolved consisting of phosphorus vapours and carbon monoxide are mixed with water vapour and a halogen acid and passed over a porous amorphous carbonaceous material as described in Specification 278,578 and yield phosphoric acid and a mixture of hydrogen and carbon monoxide having the composition of water gas.

The Latest TRADE MARKS

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VIGANTOL.

485,067.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—Bayer Products, Ltd., 31 to 34, Basinghall Street, London, E.C.2. January 11th.

MIDGIC.

48-,454.—Chemical substances prepared for use in medicine and pharmacy.—George Archibald Macfarlane, trading as Macfarlane & Son, Apothecaries Hall, 48, High Street, Fort-William, Scotland. January 11th.

AQUALIVIA.

485,866.—Chemical substances prepared for use in medicine and pharmacy.—W. Woodward, Limited, Pixley Street, London, E.14. January 11th.

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CONTENTS. PAGE.

Robert Hare: An Early American Chemist ... 65
By Edgar F. Smith.
Principal Base Metal and Base Mineral Resources of the Union of South Africa ... 67
By C. J. U. Jourdan.
General Notes:—
World's Largest High Pressure Industrial Steam Plant ... 70
Second International Conference on Bituminous Coal ... 71
World Engineering Congress at Tokyo ... 73
Proceedings & Notices of Societies:—
The Royal Society ... 74
The Physical Society ... 75
Geological Society ... 75
Application of the Algebraic Equations and Optical Designs ... 77
Forthcoming Events ... 78
New Patents ... 79
New Trade Marks ... 80

ROBERT HARE: AN EARLY AMERICAN CHEMIST.

By EDGAR F. SMITH.
(*University of Pennsylvania.*)

Has the United States of America a history of chemistry This query casually provokes a negative answer, under the impression that the country is too young. But, it must be remembered that the first settlement in the area now known as the United States was made in 1607, a period of sufficient length for the human science, Chemistry, to have received some consideration, even if it was of a primitive nature. Indeed, this really occurred, for in 1608 in the present State of Virginia, a glass-house was erected. Glass was sent to "Old England" as evidence that the new country could furnish products of economic importance. Tradition states that coloured glass beads were made and distributed among the natives to gain their friendship. It is certain that juices and colouring principles of plants were extracted and conveyed to the home country, there to be further examined for any inherent valuable properties which they might possess.

In the course of a decade several blast furnaces were constructed not far from Jamestown. Valuable ores of iron were reduced in them to metal, which followed the metal, glass, and remedial liquors to faraway England. Slags from these works are to-day visible round the locality; a specimen weighing five pounds rests on the table at which the writer now traces this history.

However, these splendidly inaugurated endeavours to apply chemical principles industrially came to an unhappy end. In 1621, the Indians, restive and suspicious of the encroachments of the white men, engaged without warning in a series of destructive and ferocious massacres, ruthlessly annihilating, at the same time, the glass-house, the furnaces, and all other factors of an on-coming civilisation, never again to be revived.

A decade or two later it was in the Massachusetts Bay Colony that enterprises of a chemical nature were inaugurated, chiefly through the efforts of John Winthrop, governor of the colony. He was aided very materially by his son, John, who became, about 1660 the governor of the Connecticut Colony. He was an early member of the Royal Society of England and had been enjoined by the Society to institute numerous chemical experiments the results of which were transmitted to the Society. His notes and books of reference are still accessible.

Sojourners in that territory encountered extensive chemical works in the vicinity of New London, the home of John Winthrop, the Younger. He was an ardent chemist. Probably both he and his father were alchymists. At least they believed in transmutation and practised it, as did many other inhabitants of early New England, and other Provinces farther to the south because Benjamin Franklin in his correspondence with eminent New Englanders, mentioned that transmutation was "practised in these parts," meaning Pennsylvania where he was a notable figure. The writer has discovered that one, Christopher de Witt, was not only a famous astrologer but that he also practised transmutation. Alchemical pursuits were in vogue in the States further south; indeed, in territory now in the far southwest of the United States th...

Spanish invaders. American historical scholars are pursuing these early tracks.

But it may be said, laying aside these initial endeavours to apply the art of the chemist, that the advent of Joseph Priestley in 1794 gave the first genuine impulse to the introduction of the scientific spirit into the chemistry existing in the New World. At that time there were many scattered throughout the young republic who had familiarised themselves with the science in European lands and had applied it upon their return to America, but it was Joseph Priestley who aroused in them the scientific spirit of research. This he accomplished to a degree by asserting the existence of phlogiston. To combat or refute his statements, hundreds of experiments were carried out and in a short while Young America placed itself on this much mooted question under the French standard. There came on the scene a new generation, and among its young men was one whose name is always mentioned with pride by American chemists. This person was Robert Hare.

Robert Hare (1781-1858), was born in Philadelphia. His earliest instruction in chemistry was received from James Woodhouse (1771-1809), who had given the death to Priestley's erroneous views on phlogiston. Hare was twenty years of age when he publicly demonstrated the burning of hydrogen and oxygen as the mixed gases escaped from a peculiarly designed exit tube; that is, he exhibited for the first time the oxyhydrogen blowpipe, yielding a flame with a temperature far exceeding that which chemists had ever been able to produce. By means of this new agent Hare melted platinum and other refractory substances. One consequence was the founding on a large scale of the platinum industry, another was the lime light and Drummond light, which contributed greatly to the welfare and comfort of the public. They were epoch-making contributions and mark their originator as an individual of more than ordinary ability. Young though he was, every moment of his time was industriously employed, for it was imperative that he should share much of his time and thought in conducting with his father an extensive and lucrative business in the brewing of ale. Somewhere in the brewery was the laboratory in which Hare conducted his experiments, and if the oxyhydrogen flame figured as a reagent, the interested spectator was invariably the distinguished Joseph Priestley.

In 1818 Hare was chosen professor of chemistry in the University of Pennsylvania. It was here that his research period began in earnest. Almost immediately he applied metallic mercury as cathode in the electrolysis of aqueous solutions of metallic salts. He thus obtained a calcium amalgam from which was subsequently obtained silver white calcium metal. This application of the mercury cathode eventually developed to a scheme for the making of caustic soda. That, however, came in after years. Hare further developed at this time the calorimotor—an ingenious galvanic device, the model subsequently for the construction of Planté's secondary battery. It was in turn followed by the deflagrator, used in electrical experiments. It was in short a "plunge battery" of unusual power, universally conceded to be a very timely and helpful discovery for those engaged in applied electrolysis. Faraday pronounced it the most perfect form of apparatus known at that time. It was the current from this device which Hare employed to fire gunpowder for the first time under water.

Hare synthesised ammonia by directing a jet of a gaseous mixture of two volumes of nitric oxide and five volumes of hydrogen on gently heated platinum sponge—undoubtedly the first attempt to use platinised asbestos for contact work of this description.

It was in 1829 that Hare constructed a covered electric furnace in which he obtained *artificial graphite from crude charcoal*, and he also made metallic calcium, phosphorus and calcium carbide. The world at large was little interested when these remarkable discoveries were made, so they laid dormant and it really was necessary that they should be rediscovered, with the consequence that the credit and honour for so doing passed to others instead of to Hare.

There were many other researches in which Hare occupied himself, for example, the cyanates, but the results were far from agreeable. He devised new processes for the isolation of a number of the elements, including boron and silicon. His famous *Compendium on Chemistry* made its appearance in 1827. This was the most original textbook on chemistry that had been published in America. It contained descriptions of most ingenious forms of useful apparatus, particularly forms adaptable in general gas analysis as well as in that of the atmosphere. His eudiometers, volumeters and volumescopes show that to a degree he anticipated Hofmann in the classic devices used in the study of water—

in its analysis and synthesis. The forms of Hare's apparatus were large and cumbersome. He was fond of experimenting on a grand scale.

His literary contributions were numerous: those with Berzelius, Faraday and Liebig were generally controversial. Thus, he contended that salts, e.g., potassium platinum chloride should be represented $K_2(PtCl_6)$ and not as a double salt $2\,KCl.PtCl_4$, as had been the case for so many years. His contentions with Liebig were on the subject of fermentation, while with Faraday they pertained to the deflagrator.

During the fifty years of Hare's activity American chemistry had many honours added to those previously won by his predecessors. He was universally regarded as an unimpeachable authority in all matters pertaining to research and was called the greatest American light of chemistry, ranking with such illustrious masters as Davy, Volta, Priestley and Berzelius.—*Archeion* (Rome).

A BRIEF REVIEW OF THE PRINCIPAL BASE METAL AND BASE MINERAL RESOURCES OF THE UNION OF SOUTH AFRICA.

By C. J. N. Jourdan.

(Paper presented to the Empire Mining and Metallurgical Congress, Montreal, August, 1927.—Contributed by Permission of the Hon. the Minister for Mines and Industries.)

(Journal of the Chemical, Metallurgical and Mining Society of South Africa.)

(Continued from page 54.)

Other Base Metals.

Antimony.

Workable masses of antimonite ore occur in the gold reefs of the Murchison Range in the Transvaal in a belt some 30 miles long. The percentage of antimony varies from 6 to 60 and gold from 3 dwts. to 1 ounce to the ton. Spasmodic attempts have been made to work one or other of the occurrences, but for various reasons these have hitherto failed. The area is to-day served by a railway and merits more skilled attention than it has received in the past, and it is possible that this belt may admit of considerable development in the future.

Chrome.

Along the margin of the Bushveld Igneous Complex of the Transvaal in several localities there occur deposits of chromite ore making in the aggregate enormous tonnages. Several of the localities are conveniently situated relative to railways, a fact which should assist Union ores in competing with chromite ore from other parts for the reason that rates on the South African Government Railways are considerably lower than on some systems in other parts of the world, notably the Rhodesian and Beira Railways.

A good beginning has been made in the export of chromite ore from the Transvaal reaching a value of £23,995 in 1925, with every prospect of an expansion of the industry.

The physical condition of chromite ore from different localities varies; in some places the ore is very hard, and consequently it carries very well; in others, again, it is more friable a feature more or less typical of most chrome ores.

Transvaal ores contain easily from 40-44 per cent. of the sesquioxide and in some localities as much as 46 to 47 per cent. Other important features in the chemical analysis are the low silica and alumina content of the chromite ore.

The following is a more or less typical analysis of Transvaal chromite ore :—

	Per cent.
Cr_2O_3	40.00—45.00
SiO_2	1.23— 2.40
FeO	24.00—29.05
Al_2O_3	10.27—13.75
MgO	6.85— 9.50
CaO	Trace— 0.26
MnO	Nil— 0.65
S	Nil—Trace
Ignition loss	— — 2.00

Copper.

The first production of copper took place in the Union about 1863 from the mines of Namaqualand in the north-west of the Cape of Good Hope ,and in 1902 the Messina Mine in the Northern Transvaal commenced operations. The total value of copper produced from the Union to date is in round figures twenty-four million pounds sterling. There are many surface indications and also ancient workings which indicate that still more copper occurrences of importance exist in the form of lodes in the old granites of the Union, but on account of the ...

some of the world's present sources of supply and which engage so much attention one almost fears these may not be explored for some time to come.

MANGANESE.

A discovery of far-reaching importance was made in 1925 of manganese ore occurrences along a line extending some 40 miles long and starting from a point two miles north of the village of Postmasburg, 145 miles west of Kimberley.

The ore body lies in the base of the Matsap Series and consists principally of psilomelane. It varies in thickness from 6 to 20 feet and the aggregate tonnage available is thus enormous. It is very hard, massive, and has a specific gravity of 4.56, while a typical analysis of the ore also proves it to conform with the specification of a true manganese ore.

At the time of writing the occurrence is under investigation by engineers representing American interests, and if their reports are favourable it is understood a railway some 65 miles long will be built to connect the fields with the main Government railway system. When this connection has been completed development and exploitation will be commenced.

The following is an approximate analysis :

	Per cent.
Metallic Manganese ...	42.00 - 58.00
Metallic Iron...	3.25—10.90
Phosphorus	Nil—Trace
Silica	1.75— 7.00
Alumina	1.00—19.00
Sulphur	0.15— 0.75

NICKEL.

There are in the Transvaal some important occurrences of nickel ores. One of these lies in the Jamestown schists of the Barberton District being a nickel silicate mixed with magnetite and locally named trevorite. A representative sample of the main outcrop yielded 17.2 per cent. of nickel, but no development has been done on the occurrence, which, however, appears to be of such an extent as to be of economic importance.

In the Rustenberg District of the same Province there occurs a magmatic zone in the Bushveld Igneous Complex containing sulphide ores of nickel ranging from 1 to 6 per cent. Dr. Wagner in his memoir remarks that there is similarity between the conditions under which this ore is found in the Transvaal and in Sudbury in Canada.

The recently discovered Merensky Platinum Reef of the Transvaal, also in the Bushveld Igneous Complex, contains some nickel and copped which will be recovered as a by-product in the process of platinum recovery, but it is not possible at this stage to say if supplies from this source will be considerable.

TIN ORE.

Tin ore in the form of cassiterite occurs in the Transvaal in pipes or chimneys in the Waterberg District. The pipe or chimney is not a filling, nor does it follow fissures or lines of weakness in the red granite in which it occurs, but it is a replacement of part of the granite by a deposition of tourmaline, quartz, and cassiterite under pneumatolytic conditions.

In the same district tin ore is also found in hard quartzites of the Waterberg Ditrict, several of which were re-discovered in recent years because of ancient workings on them.

In that district also tin bearing lodes occur in the felsites of the same geological system.

Several small mines are producing concentrates from occurrences like those described above, and also from alluvial washes derived from them. A small quantity of tin is also won in Swaziland and a little in the Cape Peninsula in alluvial derived from the grey granites of those parts.

The output of tin from the Union fluctuates between 1,500 and 2,000 tons annually of a 66 per cent. pure metal concentrate, which is shipped principally to the Straits Settlements. It is probable that this figure will be maintained for some time to come from present sources and from new discoveries that may be expected from time to time as the country is opened up and becomes more inhabited.

NON-METALLIC MINERALS.

ASBESTOS.

The Union is particularly fortunate in its possession of considerable resources in asbestos, of which the following varieties occur in workable quantity :—Chrysotile, crocidolite of Cape blue, amosite, asbestic, and tremolite.

The *chrysotile* variety—the hydrated silicate of magnesia—occurs in the serpentines in the Jamestown Series of the Barberton District of the Transvaal.

At the time of writing two mines are working asbestos on this formation, while much active prospecting is taking place with

the view of picking up possible extensions of the asbestos seams.

One of these mines, the New Amianthus, is probably the finest individual asbestos mine existent to-day. The asbestos is contained in a number of parallel seams—often as many as thirty—crowded together, and the rock contains up to 40 per cent. of fibre. The quality of the asbestos fibre from the New Amianthus Mine, of which an unusually high percentage is spinnable, leaves nothing to be desired, being very superior and highly flexible.

Hall, on page 171 of his description of this occurrence near Kaapsche Hoop, gives the following analysis No. V. by Dr. McCrae, Government Laboratories, Johannesburg, compared with VI. the mean of eleven samples of Canadian chrysotile detailed in the memoir of the Canadian Geological Survey by F. Cirkel :—

	V.	VI.
SiO_2	40.05 ...	40.49
TiO_2	— ...	—
Al_2O_3	1.90 ...	1.17
Cr_2O_3	— ...	—
Fe_2O_3	1.60 ...	2.53
FeO	.40 ...	
NiO	.25 ...	—
CoO	Trace ...	—
CaO	.15 ...	—
MgO	38.35 ...	41.41
K_2O	.15 ...	—
Na_2O	.25 ...	—
Ignition ...	16.60 ...	14.06
Totals ...	99.70 ...	99.76

Crocidolite—the blue ferrous silicate hornblende, known in industry as "Cape Blue" —is a mineral peculiar to the Union and occurs in the Cape Colony in the geological horizon known in the nomenclature of the Geological Commission of the Cape of Good Hope as the Lower Griquatown Beds, and in the Transvaal in the base of the equivalent horizon known as the Pretoria Series of the Transvaal Geological Survey. The mineral is found so far south as Keikams Poort, 30 miles south of Prieska, and so far north-east as Malips Drift in the Pietersburg District of the Transvaal. The lineal extension is in the Cape of Good Hope and Bechuanaland, thus some 300 miles, and throughout that distance it can probably be found anywhere, though not necessarily in payable quantity or of sufficient fibre length to warrant exploitation.

The mineral is possessed of many excellent properties and has found a place in industry from which it will not readily be displaced, and because of its distribution on so generous a scale the production of it is capable of expansion on a greater scale than is now the case. It is mined and dressed to-day by primitive methods by "small" mine owners, except for the Cape Asbestos Company, which works on more highly organised lines.

Blue asbestos is a good non-conductor and resists high temperatures. It is free from any material, organic or otherwise, that might react upon the surface of boilers, steam pipes, etc., under the influence of heat, moisture, or other conditions.

It is resilient and elastic and retains the shape into which it is manufactured indefinitely.

It is possessed of high tensile strength and is very durable, being able to withstand an enormous amount of wear and tear rendering it capable of outlasting, for instance, the boiler which it has covered.

It is the lightest of all incombustible and rot-proof non-conductors of heat, so that an equal weight of blue asbestos will cover twice the area that white does with the same effect. Being light, coverings made from it are easily fitted or removed for inspection without damage, but with all its lightness it is, nevertheless, stronger. Its rot-proof property makes it particularly desirable for brattice cloth or where there are insects, as they will not touch it.

It can also be manufactured into yarn of great tensile strength and durability, complete mattresses of blue asbestos stuffing, sewing and all, can therefore, be made for boiler and other purposes.

Its high non-conductivity of heat makes it a most desirable insulating material for cold storage purposes, while its non-conductivity of electricity makes its use desirable in the electrical industry.

In its resistance to the effects of acids, alkalis, chemical solutions, and sea-water, it is incomparably superior to white asbestos. It therefore makes an excellent filter fibre for acids, water, and breweries, in that is lasts longer, gives clearer products, and because of its durability filters made from it can be cleaned.

Packings for marine pumps and other machinery which come in contact with sea water are almost exclusively made from blue asbestos.

(To be Continued.)

GENERAL NOTES.

AUSTRIA.

Accelerated Economic Recovery.

The last twelve months have shown a distinct quickening in the pace of Austria's recovery, writes Mr. O. S. Phillpotts, O.B.E., British Commercial Secretary at Vienna, in his Report on conditions in Austria. Hitherto the improvement has been chiefly noticeable in the State finances, and was accompanied by a considerable measure of industrial stagnation following on the stabilisation of the currency in 1922. Since the summer of 1926 there have been symptoms of a change for the better, and these have become much more marked during recent months.

The reports of the Austrian *Institut fuer Konjunkturforschung* (which was recently founded to study economic conditions on the lines developed in America) indicate that, apart from the crisis caused by the necessity of adapting herself to the changed post-war conditions, Austria has been passing through the depression of an ordinary trade cycle. Of late the usual signs (the relations of the curves of share values, prices of goods and money rates) suggest that the country is now on the ascending curve.

WHOLESALE PRICES IN FRANCE, GERMANY, BELGIUM AND ITALY.

The index numbers of wholesale prices in November, with the exception of that for France, show no important change from October. The French index number after having dropped each month since March advanced 1.2 per cent. in November from the October figure. The indices for Belgium and Italy declined 0.1 and 0.6 per cent. respectively, while that for Germany advanced 0.2 per cent.

CANADIAN MINERAL PRODUCTION.

Large Increase in 1927.

Confirming the statement cabled by Reuter on December 30, the High Commissioner for Canada in London, is informed by the Dominion Bureau of Statistics at Ottawa that a new high record for mineral production in Canada was set in 1927, when the value of the output reached $241,733,000, marking a gain of one and one-third million dollars over the previous year's record total of $240,437,123.

New output records were established last year in gold, copper, lead, zinc, cement, gypsum and lime and in the value of natural gas and petroleum. Increased production, in comparison with the totals for 1926, was noted in the outputs of arsenic, cobalt, copper, gold, lead, nickel, platinum metals, zinc, coal, natural gas, petroleum, gypsum, pyrites, quartz, clay products, cement, lime, stone, sand and gravel.

BRIGHT OUTLOOK FOR CANADIAN MINING INDUSTRY.

"Looking backward over the year just closed, the student must be impressed with the magnificent progress made by the mining industry of the Dominion. Never before has the outlook for the future appeared brighter. In the light of the advances made during the past two years, and considering particularly the extent to which preparatory work was done in so many fields during the past twelve months, he would be a pessimist indeed who could not see a brilliant future immediately ahead in Canada's mining industry.

THE WORLD'S LARGEST HIGH-PRESSURE INDUSTRIAL STEAM PLANT.

A British Achievement.

All who are concerned with the progress of British engineering will be interested in the steam-raising plant now being constructed for Synthetic Ammonia & Nitrates Ltd., Stockton-on-Tees. This extension to the firm's plant will be the largest high-pressure plant in the world as an industrial unit, and it will be designed and constructed throughout by International Combustion Ltd. Every detail of the plant will be manufactured in this country.

America, which previously held the premier place in the construction of large pulverised fuel plants, has now had to yield this position to the achievements of British engineers.

In view of the oft-expressed opinions of Sir Alfred Mond that this country must definitely take the lead in matters of Fuel Research, Utilisation and Conservation, it is gratifying to know that the policy laid down in these words has so rapidly been fulfilled.

The fact that this extension, like others recently made, is to be constructed on the "Lopulco" system of pulverised fuel firing, is a direct recognition of the high economic value of pulverised fuel, and also of steam pressures much higher than previously used. The pressure to be employed in the Synthetic Ammonia and Nitrates installation is 800 lbs. per square inch, which, with the exception of the Milwaukee (U.S.A.) undertaking, where one boiler operates at 1.300 lbs. pressure, is the highest yet employed.

Considerable reluctance has been shown in regard to adopting pressures higher than from three to four hundred pounds. In Germany the highest pressure employed so far, has been 495 lbs., and the highest figure among American plants, apart from that already mentioned, was the Crawford Station, where 675 lbs. pressure is adopted.

It is interesting to note that the whole of these high pressure plants are associated with the use of pulverised fuel firing, a system which has made it possible to employ a plant on such lines as will provide the greatest economy in steam-raising. The plant at which previously the highest pressure was employed in this country is that of the Leeds Corporation new electricity extension, the boilers working there at 450 lbs. pressure. This contract also was placed in the hands of International Combustion Ltd.

Details of the New Plant.

In the new plant for Synthetic Ammonia and Nitrates Ltd., each of the six boilers capacity of 260,000 lbs. maximum evaporation, the final temperature being at the high figure of 840° F. The design of the pulverised fuel plant will be on the Bin and Feeder principle, every wall of the combustion chamber being entirely water-cooled. The new type of "R" burner recently evolved by International Combustion Ltd., will be embodied, the advantages of this being that it will effect a considerable reduction in the size of the combustion chamber, and the second is that it will obviate any possible segregation of the fuel. The Raymond Mills, which will be installed for grinding coal, are to be designed ou the closed system. No dryers are to be employed, the drying of the coal being effected in the mill circuit. The plant for handling coal will be on a larger scale than has yet been adopted, and will have a capacity of 3,800 tons per day. For ash sluicing, the "Usco" system will be used. The volume of steam to be dealt with from this plant every 24 hours will amount to 11,700 tons, this being passed through high-pressure turbines for the production of electricity.

FIRST SMOKELESS SPA.

Following a recent suggestion that a Smoke Abatement Society should be formed for Harrogate, with the object of making it the first smokeless spa, efforts are now being made to popularise the use in the town of the residual smokeless fuel of low temperature carbonisation, which is now being successfully produced in Yorkshire.

During the past few days, there has been a remarkable demand for coalite, and the principal hotels, the Royal Bath Hospital, the Medical Officer of Health and well-known local doctors, and the local Education Committee are now experimentally using the smokeles residual fuel for the purposes of heating. Thd results of the tests are expected to have an important bearing on the demand for the product of the new industry.

SECOND INTERNATIONAL CONFERENCE ON BITUMINOUS COAL.

Carnegie Institute of Technology.
Schenley Park, Pittsburgh, U.S.A.
November 19 to 24, 1928.

The Carnegie Institute of Technology announces a Second International Conference on Bituminous Coal to be held at Pittsburgh, U.S.A., November 19 to 24.

The purpose of the Congress is similar to the one held in 1926 by the Carnegie Institute of Technology; to present the results of recent studies of coal that have to do with improved methods of utilization and combustion. The programme will include the discussion of the fixation of nitrogen, the manufacture of substitutes for gasoline from coal, complete gasification of coal, high temperature distillation, low temperature distillation, coal tar products, power, smokeless fuel, etc.

An invitation is extended to scientists of all countries to take part in this Conference.

The President if the Carnegie Institute of Technology, Thomas S. Baker, will visit some of the principal cities of Europe during the months of March and April, 1928, to confer with fuel technologists who may consider the possibility of presenting papers of taking part in the Congress in any other way. President Baker's address after February 25, will be care of the Guaranty Trust Company, 1, rue des Italiens, Paris, where he will be glad to receive correspondence in regard to the meeting.

The Advisory Board of the Conference includes the following American men of affairs :— Mr. John Hays Hammond, Mr. E. M. Herr, Mr. Samuel Insull, Mr. Frank B. Jewett, Mr. Otto H. Kahn, Mr. George E. Learnard, Mr. A. W. Mellon, Mr. Auguste G. Pratt, Mr. Charles M. Schwab.

A more detailed statement will be issued later concerning the Congress and will be sent to foreign governments, scientific and industrial organisations and to individuals who are interested in fuel technology.

DEPARTMENT OF OVERSEAS TRADE.

The Commercial Secretary at Cairo reports that the Department of Public Health, Cairo, is inviting tenders for supplies for the year commencing 1 may, 1928 to end 30 April, 1929, as follows :—

(*a*) Proprietary Articles.
(*b*) Sundries (including bottles and jars, filter paper, medical soaps, etc.)
(*c*) Dressings.
(*d*) Drugs and Chemicals.
(*e*) Galenicals and packed articles.

Tenders will be received by the Director of Stores, Department of Public Health, Cairo, up to noon on the 29 March, 1928. United Kingdom firms desirious of receiving further particulars of this call for tenders should apply to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. Reference B.X., 4172 should be quoted.

PROBLEM OF KEEPING WARM.

NATURE'S "MARVELLOUS MECHANISM" FOR REGULATING BODY HEAT.

Some interesting facts regarding the methods by which the human body is kept warm were given on January 18, in a paper before the Royal Society of Arts by Mr. A. H. Barker, B.Sc., M.I.E.E., lecturer on Heating and Ventilation to the University College, London.

According to Mr. Barker, the human being is kept warm not from without but essentially from within; by chemical processes proceeding in the interior of the body, which furnish a continual supply heat derived from the combustion of the food substances. To prevent the accumulation of such heat, it is necessary that it shall be removed as fast as it is generated—no faster and no slower.

One of the most marvellous mechanisms in the whole of Nature, said Mr. Barker, was by which the balance of heat was maintained. The perfection of the process was secured when the person concerned was unconscious of any discomfort or variation of condition.

Dealing with the different methods of external heating, the lecturer stated that the sensation of cold could be avoided in two ways, (1) by raising the air temperature around the body to a suitable degree; and (2) by allowing radiation from warm objects to impinge on the body, the air temperature being at a much lower degree than this. The difference in effect between the two processes was very great. The warming of th air produced an indefinable feeling of stuffiness, while the person heated by radiation in cool air felt warm and fresh.

"For countless years," said Mr. Barker, "methods of heating by incandescent radiation have been in use, of which the oldest is the old open coal fire.

"This method, many as are its advantages, is, of course, about the crudest and most extravagant that could easily be conceived. Functionally, it consists in using up the energy of the sun, which has been distributed over the earth ages ago and has been chemically absorbed. Early discoverers found this deposit of concentrated energy in the earth in the form of wood and coal, and found that by setting it alight they could release its energy again and use a small fraction of it. No cousiderations of economy in its use entered their heads.

"This open fire process has been improved in efficiency, convenience and economy, by extracting from the solid fuel a gas of which the advantages are that it is readily carried to the point where it is to be burnt, that its combustion leaves no solid residue, and that the rate of combustion can be regulated by a tap. There are very great advantages. Functionally, the effect of a gas fire is identical with what has already been described. There is no difference between the physical effct of a coal and a gas fire properly fitted with a suitable flue. The idea that a gas fire provides drier radiant heat than a coal fire is merely absurd."

ON THE CHEMICAL CONSTITUTION OF SELACHOLEIC ACID.

By MITSUMARU TSUJIMOTO.

In 1925 the author discovered an acid of the composition $C_{24}H_{46}O_2$ from Aizame liver oil and named it "selacholeic acid." The

fits into a higher homologue of oleic acid series. The present paper treats of the author's experiments on the constitution of the acid. Firstly, the hydrogenated selacholeic acid (the author's "isoselachoceric acid"), $C_{24}H_{48}O_2$, m.p. 83.5° C., was compared with synthetically prepared *n*-tetracosanic acid, m.p. 84° C. The mixture of equal parts of these acids melted at 83.8° C. without showing depression; so the straight C-chain structure of selacholeic acid has been confirmed. Secondly, the position of ethylenic linkage of the acid was determined by the ozone method. The acid gave the normal ozonide $C_{24}H_{46}O_5$; on decomposing it with water, nanylic acid $C_9H_{18}O_2$ and tridecan αν dicarboxylic acid $(HO_2C)(CH_2)_{13}(CO_2H)$, m.p. 113° C. were identified with certainty. The chemical constitution of selacholeic acid has, therefore been confirmed to be

$$CH_3.(CH_2)_7.CH : CH.(CH_2)_{13}.CO_2H.$$

Quite recently the author has noticed the investigation of E. Klenk. As the so-called "Nervonsäure" has the same constitution as selacholeic acid, these two acids are probably identical.

WORLD ENGINEERING CONGRESS IN TOKYO, OCTOBER, 1929.

A World Engineering Congress is to be held at Tokyo for two weeks toward the end of October, 1929, under the auspices of the Kogakkai, the Engineering Society of Japan, a body which unites twelve technical societies for the purpose of co-operation and includes the societies relating to mining, iron and steel, civil engineering, architecture, naval architecture, ordnance and explosives, electrical engineering, mechanical engineering, illuminating engineering, telephony and telegraphy and industrial chemistry. The participation therein of Governmental department, universities, institutes, associations and individuals collaborating in engineering is invited.

The Congress proposes to discuss various engineering subjects in anticipation eventually to initiate and promote the international co-operation in the study of engineering science and problems in all its branches and to cultivate a feeling of brotherhood among engineers of the world.

More detailed announcements will be issued later. Correspondence and enquiries should be addressed in the meantime to the Kogakkai, Marunouchi Building, Tokyo.

THE BERTHELOT CENTENARY IN TOKYO.

On October 25 a meeting was held in Tokyo for the celebration of the centenary of Marcellin Berthelot. It was attended by many chemists, and among those present were the French Ambassador, Baron Jujita, Baron Sibusawa, and Viscount Ishii. Prof. Sakurai, President of the Imperial Academy, made a speech, and Prof. Matsubara gave an address about the life and work of this great chemist.

THE INSTITUTE OF CHEMISTRY.

30, Russell Square, London, W.C.1.

The Fourth Annual Dance will be held at The Hotel Russel, Russell Square, W.C.1., on Wednesday, 15 February, 1928, at 7.30 for 7.45 p.m.

Frederick Arthur's Dance Band will be in attendance.

Carriages at midnight. Ample garage accommodation is available in the vicinity. Russell Square Tube Station communicates with all parts of London and the Suburbs. Members wishing to spend the night in London should make early application for accommodation to the Manager of the Hotel.

Tickets, 7s. 6d. single, 14s. double, including refreshments), can be obtained from the undersigned.

E. H. Hughes,
Hon. Secretary.

THE CO-PARTNERSHIP PRINCIPLE.

In order to encourage their employees to become shareholders in the company, Imperial Chemical Industries Limited are giving special facilities for doing so. Any employee of one year's standing can invest each year up to 20 per cent. of his wage or salary, and can pay for the shares if necessary by easy instalments. Employees on over five years' standing can invest a larger proportion of their year's remuneration in the shares. The price will be in all cases 2s. 6d. per share less than the market quotation the previous week. Further, the company will arrange to give a bonus of one *free* share for every four shares subscribed for if the yearly remuneration be £200 or less, or one bonus share for each five shares subscribed for if the remuneration be from £201 to £500 per annum.

Clearly, the company is determined to enable their employees to take a big upward step towards becoming capitalists in a small

way. The scheme will, of course, also be beneficial to the company, but it will be much more useful to the workers, not only directly, but also by inculcating among them the thrift habit, which, if duly learned and assiduously practised, will enable the workers to look forward to the future with greater confidence than if they were mere wage-earners, without any further interest in th welfare of the business from which they in the welfare of the business from which they get their living. The promoters of beneficent schemes of this kind are the real friends of the working classes, and they are also doing their part in promoting peace in industry and the general welfare of the whole community.

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.

The following papers were read at the meeting held on Thursday, January 26 :-

The Formation of Crystals of β-Brass. By G. I. Taylor, F.R.S.

It is shown that β-brass, which has a crystal structure similar to that of old iron, behaves in a similar, though not identical, manner when distorted.

The peculiar feature of the distortion of iron crystals, namely, the fact that slip does not occur on a definite crystallographic plane, is repeated in β-brass within a certain range of orientations of the crystal axes in the specimen. On the other hand, in another range of orientations slip occurs on a definite crystal plane of type {110}. The conditions which determine which of these types of distortion will occur in any given case are investigated, and it is shown that the determining cause is the variation in resistance to shear which occurs as the plane of slip rotates about the direction of slip. This variation is calculated from the experimental results within the range to which they apply, and it is shown that resistance to shear is least when the plane of slip coincides with a crystal plane of type {110}. On either side of this position shear stress increases linearly, there being a discontinuity in the rate of change of shear strength with orientation of plane of slip. This peculiar property is also possessed by the model consisting of hexagonal rods proposed by the author and Miss Elam, and by Mr. Hume Rothery's models, which, from this point of view, is identical with the model of hexagonal rods.

The assumptions made in a recent paper by Mr. Hume Rothery are discussed, and it is shown that in a body-centred cubic structure like α-iron they lead, when analysed, to the conclusion that slipping should always take place parallel to a crystal plane of type {110}, and not, as he stated, to the conclusion that slip should occur on the non-crystallographic planes which were actually found.

It is shown also that in β-brass resistance to slipping in one direction on a given plane of slip is not the same as resistance offered to slipping in opposite direction. Such a difference is to be expected from crystallographic symmetry, but was not observed in α-iron.

The Behaviour of a Single Crystal of α-Iron Subjected to Alternating Torsional Stresses. By H. Gough. Communicated by T. E. Stanton, F.R.S.

A single crystal of α-iron has been subjested to various ranges of alternating torsional stresses, leading to elastic and total failure. Changes in microstructure, and method of failure in relation to crystallograhic structure and to the stressing system, have been studied by mechanical, microscopical and X-ray methods.

The results indicate that direction of slip coincides with that of most highly stressed principal line of atoms. Four such possible directions of slip exist within the crystal, each being parallel to the normal to one of the four sets of octahedral planes, and at any point on circumference of crysta lthere exists a plane on which the value of shear stress on the plane resolved in one of the octahedral directions is a maximum.

In the general case, this plane of maximum resolved shear stress is *not* a crystallographic plane of low indices, and slip will only occur on this plane if the latter happens to coincide with a dodecahedral (110), icositetrahedral (112) or hexakis-octahedral (123) plane; also deformation occurs by slip on *two* crystallographic planes, each plane belonging to one of these three types.

These slip planes are *not* both of one crystallographic type and are situated on opposite sides of the plane of actual maximum resolved shear stress, being determined by the fact that each slip plane is subjected to a greater value of resolved shear stress than any other available slip plane situated *on the same side of the plane of maximum resolved shear stress.* Owing to the geometry of the structure under these conditions, slip only occurs on one of the following two combinations of planes :—

(*a*) 110 and 123, or (*b*) 112 and 123. It cannot occur on a 112 plane combined with a 110 plane.

THE PHYSICAL SOCIETY.

Friday, December 9, 1927, at the Imperial College of Science.

Prof. D. W. Richardson, M.A., D.Sc., F.R.S., in the chair.

Percy Wilson, M.A., was elected a Fellow of the Society. The President announced that the Council had elected Robert William Sutton a Student Member of the Society.

The following papers were read :—

The Scattering of Light by Individual Particles in Smokes. By H. P. Walmsley.

Applying the expression given by Maxwell for the number of collisions that occur between two sets of spherical uncharged molecules in a gas to the case of a smoke whose particles cover a wide range of sizes, it appears that particles of a given set collide less frequently with themselves than with those in sets of much larger or much smaller size. If the particles unite on contact, one would expect therefore that the units of the resulting aggregates would differ greatly in size. As this result is at variance with the deductions of Patterson and Whytlaw Gray from experimental data, the validity of their argument is discussed.

On the Construction and Standardisation of an Interferometer Pressure Gauge. By J. J. Manley, M.A., Research Fellow, Magdalen College, Oxford.

This paper deals with the application of a Michelson interferometer to the determination of gas pressures ranging from 0.0001 to 20 mm. of mercury. The construction of the instrument is fully described as are also the methods used for standardising the registering micrometer screw and its graduated head. The gauge can be instantaneously set and the pressure which obtained at the moment of setting measured at leisure.

The Dielectric Constant of Liquid Bromine. By Anne I. Anderson, B.Sc.

An account is given of a re-determination of the dielectric constant of liquid bromine, the value found being 3.199 at 15° C., and at a frequency of 187,000 per sec., with a temperature coefficient of − 0.00191 referred to 0° C. Applying the dipole theory of Debye and Gans to the results, a value of 0.40×10^{-18} is deduced for the electric moment of the bromine molecule Br_2. The electrical conductivity was also measured.

MINERALOGICAL SOCIETY.

The following papers were read at the meeting held on January 10, Dr. G. T. Prior, F.R.S., President, in the chair :—

Potarite, a New Mineral Discovered by the late Sir John Harrison in British Guiana. By Dr. L. J. Spencer.

Small nuggets and grains of a brittle white metal have been found very sparingly by diamond-washers in the neighbourhood of the Kaieteur Falls on the Potaro River. This mineral, previously erroneously described as "allopalladium," was proved by Harrison to be a compound of palladium and mercury, PdHg, with a density (15.0-16.1) considerably higher than that of either of theh component metals. There is a crystalline structure which on the surface of one nugget is shown as indistinct cubic octahedra. The original "allopalladium" from the Harz Mts., supposed to be a hexagonal modification of palladium, could not be procured for a re-examination; it is probably the ordinary cubic palladium.

A Simple and Accurate Constant-Volume Pyrometer for Specific gravity Determination. By Dr. H. V. Ellsworth.

The pyrometer of 10 c.c. capacity is made of silica-glass, thus possessing several advantages over one made of ordinary glass. The stopper is perforated by a capillary and is continued into a graduated side-tube, which dips under water while the apparatus is cooling. The volume of the contained water to the graduations on the side-tube can be readily and accurately determined to 0.00002 c.c.

The Optical Orientation of Labradorite from County Down (Ireland), Determined by the Fedorov Method. By W. Campbell Smith.

The labradorite from basaltic dikes at St. John's Point, Ardglass, Co. Down, of which the chemical composition and refractive indices were published in 1912 has been studied by the Fedorov method and the optical orientation determined.

Dr. C. E. Tilley demonstrated the inversion of $CaSiO_3$ in a metamorphic limestone from Larne, Co. Antrim (Ireland); and Mr. A. F. Hallimond exhibited an electromagnetic separator for mineral powders.

GEOLOGICAL SOCIETY OF LONDON.

The following communication was read at the meeting held on January 11, 1928 :—

The Geology of South-Eastern Arabia. By George Martin Lees, M.C., D.F.C., F.G.S.

South-Eastern Arabia consists of two separate tectonic and stratigraphic provinces: (1) A foreland where, as at Dhofar, ancient gneiss is overlain by a 'Nubian' type of desert-sandstone. The first marine transgression took place in the Cenomanian; (2) an orogenetic zone of typical Alpine character. The presence of nappes is indicated by great overthrusts, klippen, and by the stratigraphic differences between adjacent units. The movement is of pre-Gosau age. Upper Cretaceous and Tertiary strata lie with strong, often vertical, unconformity on the older Mesozoic and Palaeozoic rocks.

The stratigraphy of the orogenetic zone consists of:

(i) A series of pre-Permian formations of unknown age.

(ii) Permian dark-blue and black fossiliferous limestones. Near Jebel Rais limestones of a different facies appear as tectonic klippen; they are Crinoidal, Coral, Bryozoonal, and *Neoschwagerina* limestones.

(iii) Upper Triassic limestones, sandstones, and shales. The fauna consists of lamellibranchs and gasteropods; no ammonites have been found.

(iv) Jurassic to Lower Cretaceous massive limestones.

(v) ? Upper Jurassic to Lower Cretaceous shales, sandstones, and red and green radiolarites. This group probably belongs to a different tectonic unit from (iv).

(vi) Hatat Schists. A series of calc- and sericite-phyllites of unknown age, probably Mesozoic, which appear as a tectonic window at Saih Hatat.

(vii) Basis igeneous series—lavas and intrusive rocks.

(viii) Unconformable Upper Cretaceous to Miocene conglomerates, limestones, and marls. The Maestrichtian is exceptionally fossiliferous.

The relation of Oman to the Zagros arc is discussed. The characteristic zone with red and green radiolarites and shales and basic igneous rocks occurs again in Persia, and forms great tracts of country south-west of Kerman. Here also Upper Cretaceous rocks are strongly unconformable. One great branch of the Cretaceous orogenetic zone of Central Persia must, therefore, have passed southwards into man. The Upper Cretaceous-Tertialy geosyncline broke down across the older strike, and pursued an independent direction parallel to the present Persian Gulf-Mekran coast. The late Pliocene movements also followed this trend, the influence of the older tectonics only being shown in the marked swing of the strike betwen Bandar Abbas and Jashk. Such a complete independence of these two phases of Alpine movement is unique.

The Oman orogenetic zone may be followed through Masirah Island to Ras Madhraka, where it passes southwards into the Arabian sea. The Kuria Islands belong already to the foreland.

A further movement, though of much less intensity, took place in Oman in post-Miocene time. South of Sur these folds strike north-west and south-east, and appear to pass out to sea at Ras al Hadd, independent of, and across, the older structures. Perhaps these folds form a continuous loop with the Kirthar Range of Sind, but no connection can have existed between the latter and the Cretaceous orogen of Oman.

The Triassic, Lower, and Upper Cretaceous fossils are described. They include twelve new species.

THE OPTICAL SOCIETY.

At the meeting of the Optical Society, held at the Imperial College of Science and Technology, on Thursday, 19 January, 1928, the following papers were read:—

On Toric Lenses. By T. SMITH, M.A., F.Inst.P., Optics Department, The National Physical Laboratory.

A system of toric lenses having a common normal to all their surfaces possesses in general ten independent primordial coefficients. A single surface has only three degrees of freedom, and this number also holds for any system of negligible axial depth. Formulæ are given for the calculation of the ten coefficients, which are only all independent when the system includes at least three separated toric refracting surfaces with their planes of principal curvature finitely inclined to one another. An eye with both its cornea and its crystalline lens astigmatic and the meridians of principal curvature different has more independent coefficients than a spectacle lens has effective degrees of freedom. The nature and importance of the unavoidable residual errors in central vision when such an eye is corrected by a toric lens are discussed.

Canonical Forms in the Theory of Asymmetrical Optical Systems. By T. SMITH M.A., F.Inst.P., Optics Department, The National Physical Laboratory.

Canonical forms for the quadratic terms of the eikonal and of the characteristic function for any optical instrument are found to involve only six arbitrary con-

stants. The seven constant canonical form of the characteristic function obtained by Larmor is not general. Larmor's theorem on the equivalence of any optical system to a symmetrical instrument together with two thin astigmatic lenses also fails. Three separated astigmatic lenses are needed to represent the general system.

Some Remarks on an Extension of the Optical Cosine Law. By M. HERZBERGER, Ph.D. (Messrs. Ernst Leitz, Wetzlar).

In this note reference is made to an extension of the optical cosine law, a full description of which will appear in the *Zeitschrift fur Physik.*

Votes of thanks were accorded to the authors.

Mr. Fawcett, of Messrs. The Tintometer, Limited, demonstrated the Rosenheim-Schuster Colorimeter based on Lovibond's Colour System. This instrument is designed for the rapid matching of colours of transparent substances in terms of the Lovibond Colour Scale. It is particularly applicable for Biochemical purposes and has been used with success for Vitamin A Estimations.

Votes of thanks were passed to Messrs. The Tintometer, Limited, for arranging the demonstration and to Mr. Fawcett for demonstrating and explaining the instrument.

APPLICATION OF THE ALGEBRAIC ABERRATION EQUATIONS TO OPTICAL DESIGN.

By I. C. GARDNER.

(*Scientific Paper, U.S.A. Bureau of Standards.*)

ABSTRACT.

The phase of optical engineering which deals with lens design and the measurement of the aberrations of a lens system is worthy of a more comprehensive treatment than is available in English. Even in our technica lschools and universities it is seldom that one finds a course dealing adequately with optical imagery which goes beyond the first order or Gaussian equations. In geometrical optics there are two applications of the aberration equations. In the first, one has what may be termed the direct problem. The specifications of the lens system are given and the aberrations are to be determined. In the inverse problem one is to determinn the specifications of the lens system which will have the desired aberraion characteristics. Altnough the second problem is much the more important the literature dealing with it is relatively meagre. There is no treatise entirely satisfactory, either in German or English, which gives the third order aberrations in a convenient form for the inverse solution with a simple and consistent notation and sign convention.

And yet the control of the aberrations of a projected system is the central problem of optical design. To understand the aberrations, one must have had experience in computing and in measuring them. The need of a treatment of the aberrations covering a different field than that of the existing treatises has often been felt and has been recently well expressed by Mr. Emly at a meeting of the Optical Society of London, in which he says, "It is when the student attempts to get hold of expressions from which he can calculate these quantities (aberrations), however, that his difficulties begin. There is no standard English work leading him from his elementary geometrical and physical optics to problems of this kind. It has always seemed to me that there is a distinct gap in the subject which, looked at from any point of view, should be filled. There are many advanced works on instrument design and other specialised problems, but the ordinary type of student I have in mind can not follow them, partly because of the gap alluded to and partly because of the variety of symbols and constants used."

It is hoped that the following treatment will partially fill this gap and at the same time serve as a reference book for the solution of problems in lens design. The laboratory measurement of the aberrations is not dealt with. The aberration equations are presented in such a manner as to permit their direct application to problems of lens design. Only the assumptions of geometrical optics in the restricted sense are applied, and all references to diffraction effects, resolving power, and kindred subjects are omitted. The derivations of the equations are omitted except for a brief reference in Appendix 2, and the physical interpretation and manner of application of the equations to problems is stressed. It is the intention thus to produce a grammar or handbook for reference which will contain the information necessary for the algebraic third order design of optical systems composed of thin lenses.

The second system, termed the Taylor system, was originated by Coddington and much extended by Taylor. Modifications have been introduced into the Taylor-Coddington equations which simplify them in

appearance and which enable the two systems of equations to be carried along in parallel throughout the treatment. The reader can, accordingly, make his own choice as to which group of equations is to be used.

The notation employed is substantially that of Schwarzschild and von Rohr, and its choice is justified by the wealth of material already published in which this notation is employed. Some slight changes have been made to avoid confusion when the notation shall be extended to projected publications dealing with the stage of optical design in which trigonometric ray tracing is employed. To avoid the attachment of two significations to the same symbol, it has been necessary to depart from the notation of Taylor in many instances. The sign convention adopted is the one believed to be most nearly universal in treatises on applied optics.

The first order equations of imagery are dealt with only in such detail as is necessary to provide the basis of notation and sign convention to be used in the third order equations. The equations and a general description of each third order aberration for a single lens are given, after which the equations are extended to a system of thin lenses. A general discussion of the method of controlling the aberrations of an optical system follows with two numerical examples. In the first example the aberrations of a Ramsden eyepiece are determined. In the second example a Kellner eyepiece is designed to have given aberration characteristics. This last illustration is worked out in considerable detail in order to illustrate fully the different applications of the third-order equations. Following this there are given the equations for the third-order aberrations of thick plates or reflecting prisms and the method of their application to the design of optical systems which contain thin lenses and reflecting prisms or plane parallel plates.

FORTHCOMING EVENTS.

INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, Victoria Embankment, London.

Thursday, February 9.—Annual Dinner at the Hotel Cecil, Strand, London, at 7.30 p.m.

INSTITUTE OF METALS.

London Section, at the Rooms of the Society of Motor Manufacturers and Traders Limited, 83, Pall Mall, London, S.W.1.

February 9, at 7.30 p.m.—" Properties of Metals and Alloys at High Temperature." by N. G. Batson.

North-East Coast Section, at Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne.

Tuesday, February 7 at 7.30 p.m.—Demonstration of Mechanical Testing of Metals. By J. A. Smythe, D.Sc., Ph.D., and C. E. Pearson, M.Met.

Sheffield Local Section, at the Non-Ferrous Section of the Applied Science Department of the University, St. George's Square.

Friday, February 10, at 7.30 p.m.—" Casting." By J. B. Forster, M.Sc.

Swansea Local Section, in Thomas' Cafe, High Street, Swansea.

Wednesday, February 8, at 7 p.m.—" Gases in Metals, with Special Reference to Copper." By N. Alan, M.Met.

Birmingham Section, at Engineers' Club, Waterloo Street, Birmingham.

Tuesday, February 7, at 7 p.m.—" Testing of Metals." By Prof. F. C. Lea, O.B.E., D.Sc.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

36, George Street, Manchester.
Tuesday, February 7, at 5.30 p.m.

OIL AND COLOUR CHEMISTS'

At Milton Hall, Deansgate, Manchester.

Friday, February 10, at 7.30 p.m.—" Nitro Cellulose Lacquers—Recent Developments." By Dr. Stanley Smith, O.B.E.

Thursday, February 9, at 8 p.m., at 8, St. Martin's Place, Trafalgar Square, London. —" Malayan Damars." By T. Hedley Barry.

PEOPLE'S LEAGUE OF HEALTH.

Wednesday, February 8, at 6 p.m., at the Medical Society of London Lecture Room, 11, Chandos Street, London, W.1.—" Habit and Adaptation." By. Dr. R. D. Gillespie.

ROYAL INSTITUTE OF PUBLIC HEALTH.

Lecture Hall, 37, Russell Square, London, W.C.1.

Wednesday, February 8, at 4.30 p.m.—" Some Problems of Forensic Psychiatry." By W. Norwood East, M.D. (Lond.).

ROYAL SOCIETY OF ARTS.

John Street, Adelphi.

Wednesday, February 8, at 8 p.m.—"Theatre Lighting." By Henry D. Wilkinson, M.I.E.E.

Friday, February 10, at 4.30 p.m.—Indian Meeting "Bihar and Orissa." By Sir Edward A. Gait, K.C.S.I.

THE ROYAL INSTITUTION.

Albemarle Street, London.

Monday, February 6, at 5 p.m.—General Meeting.

Tuesday, February 7, at 5.15 p.m.—Prof. A. P. Newton: "The Settlement of the Dominions, 1783-1870."

Thursday, February 9, at 5.15 p.m.—Sir William Bragg: "From Faraday's Note Books."

Friday, February 10, at 9 p.m.—Prof. B. Melvill Jones: "Research on the Control of Aeroplanes."

Saturday, February 11, at 3 p.m.—Mr. H. C. Colles: "Musical London (1660-1759)."

THE OPTICAL SOCIETY.

Imperial College of Science and Technology.

Thursday, February 9, at 7.30 p.m.—Annual Meeting.

THE ROYAL SOCIETY.

Burlington House, London, W.1.

Thursday, February 9, at 4.30 p.m.—O. W. Richardson, F.R.S.: "On the Extraction of Electrons from Cold Conductors in Intense Electric Fields." R. H. Fowler, F.R.S.: "The Restored Electron Theory of Metals and Thermionic Formulæ." R. H. Fowler, F.R.S.: "The Photo-Electric Threshold Frequency and the Thermionic Work Function." P. A. M. Dirac: "The Quantum Theory of the Electron." Communicated by R. H. Fowler, F.R.S. H. T. Flint and O. W. Richardson, F.R.S.: "On a Minimum Proper Time and its Application to (1) the Number of the Chemical Elements, (2) Some Uncertain Relations." Several other important papers will be read in title only.

UNIVERSITY OF LONDON.

University College, Gower Place, London, W.C.1.

Monday February 6, at 2 p.m.—"The Heroic Poetry of Old Russia." A public lecture by Prince Dimitri S. Mirsky.

Tuesday, February 7, at 5.30 p.m.—"Trade Unions and the Law." A public lecture by Sir Henry Slesser, K.C.

At 8.15 p.m.—"More London Place Names." First of a course of five lectures by Miss E. Jeffries Davies. Repetition of course given in November, 1927). Other lectures, February 14, 21, and 28, and March 6.)

Wednesday, February 8, at 5.30 p.m. The Dutch Mediæval Play: "Mary of Nimweghen." A public lecture by Mr. J. Haautjes.

Also at 5.30 p.m.—"Norwegian Country Life, Customs and Sayings." First of three public lectures by Mr. I. C. Grondahl. (Other lectures, February 15 and 22.)

Thursday, February 9, at 5.30 p.m.—"Relics of Monastic London." A public lecture by Percy Fleming, F.R.C.S. (with lantern).

Also at 5.30 p.m.—"L'estetica del Groce" (Italian) By Dr. Camillo Pelizzi.

Friday, February 10, at 5.30 p.m.—"Chemistry in Mediæval Islam." A public lecture by Dr. E. J. Holmyard, of Clifton College, Bristol.

CELEBRATION DU CENTENAIRE DE BERTHELOT.

On February 11, at 3.15 p.m., at the London Day Training College, Southampton Row, London, M. Moureu, membre de l'Institut de France, Professor at the College de France and Head of the Research Station of Meudon, is coming to England in order to give a lecture on his famous predecessor, Marcelin Berthelot. The French Ambassador will be present.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

1,136.—Chemische Fabrik vorm. Sandoz.—Emetine salts. January 12th.

1,338.—Grace, C. J.—Means of producing an emulsion of sulphur in water. January 14th.

813.—Hull, P. H.—Effecting chemical reactions in gases. January 10th.

1,097.—I. G. Farbenindustrie Akt.-Ges.—Production of acetic acid, etc. January 12th.

708.—Smith, W.—Production of dyestuffs. January 9th.

Specifications Published.

283,232.—Brightmore, J. Fixation of atmospheric nitrogen.

258,576.—I. G. Farbenindustrie Akt.-Ges. —Purification of crude benzol.

259,944.—I. G. Farbenindustrie Akt.-Ges. Manufacture and production of motor fuels.

271,482.—Muller, K.—Process for the production of synthetic ammonia.

272,155.—Soc. Chimique de la Grande-Paroisse, Azote et Produits Chimiques. Process for the manufacture of formaldehyde.

Abstract Published.

281,134.—*Calcium formaldehyde-sulphoxylate.*—I. G. Farbenindustrie Akt.-Ges., *Frankfort-on-Main, Germany.*

A difficultly soluble calcium formaldehyde-sulphoxylate having 4 atoms of sulphur to 3 atoms of calcium in the molecule is precipitated from an aqueous solution of sodium formaldehydesulphoxylate by means of a mixture of a soluble calcium salt *and calcium hydroxide or carbonate. Either* the soluble calcium salt or the calcium hydroxide or carbonate may be prepared in situ. Caustic soda or potash or alkali carbonate may be used to precipitate a portion of the soluble calcium salt previously added, or an acid such as hydrochloric may be *added to the calcium hydroxide already* present for the formation of the soluble calcium salt. In examples, sodium formaldehydesulphoxylate in aqueous solution is treated with calcium chloride and milk of lime, *calcium* chloride and caustic soda and calcium chloride and soda ash. Since in the process monocalciumformaldehydesulphoxylate is first formed this may be used as the starting material which is then treated treated with calcium hydroxide or carbonate.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

FRESTIC.

485,881.—Chemical substances prepared for use in medicine and pharmacy.—William George Duck, trading as Duck and Son., 28, 30, 32 and 34, High Street Arcade, St. John's Square, Cardiff. January 18th.

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CONTENTS. PAGE.

The Action of Sulphuric Acid on Copper 81
By J. G. F. Druce, M.Sc.(Lond.), R.Nat.Dr.(Prague), F.I.C.
Principal Base Metal and Base Mineral Resources of the Union of South Africa 84
By C. J. V. Jourdan.
General Notes :—
Inventor Suggests Calendar Change 87
Fire Without Smoke 88
U.S.A. Automobile Manufacturers in Canada 88
Pulverised Fuel Progress 89
Proceedings & Notices of Societies :—
The Royal Society 90
The Chemical Society 91
Society of Glass Technology 92
Institute of Metals 93
Notices of Books 93
Forthcoming Events 94
New Patents and Trade Marks 96

Obituary.

DEATH OF PROF. A. LORENTZ.

Prof. H. A. Lorentz, the celebrated Dutch physicist, died at Haarlem on February 4, at the age of 75. He made many important discoveries on the phenomena connected with light. His theory of reflection and refraction of light appeared in the *Chemical News*, 1877, XXXVI, 152. Since then a number of his works have received notice in this Journal.

THE ACTION OF SULPHURIC ACID ON COPPER.

By J. G. F. DRUCE, M.Sc. (Lond.), R.Nat.Dr.(Prague), F.I.C.

In the usual laboratory method for preparing sulphur dioxide by the action of concentrated sulphuric acid upon copper there remains in the generating flask a black residue, which, according to the usual equation given for the reaction :

$$Cu + 2H_2SO_4 = CuSO_4 + 2H_2O + SO_2$$

should consist of copper sulphate and unchanged reactants. The fact that the residue is not blue is usually ascribed to the copper sulphate being anhydrous. It should therefore be white. The black sludge is generally assumed to be copper sulphide, CuS. It has occasionally been mistaken for copper oxide.

It does not appear to be generally realised that the most stable sulphide of copper is cuprous sulphide, Cu_2S, and this constitutes the bulk of the black substance formed during the action of sulphuric acid on copper. When the reaction is carried out at 120-170° C., *i.e.*, the temperature at which sulphur dioxide begins to come off conveniently, ten per cent. or more of the copper attacked is converted into cuprous sulphide :—

$$5\ Cu + 4H_2SO_4 = Cu_2S + 3CuSO_4 + 4H_2O.$$

The formation of cuprous sulphide predominates at lower temperatures whilst the brisk evolution of sulphur dioxide does not occur much below 150-170° C., although traces can be detected at even ordinary temperatures.

It can be shown that at higher temperatures, less copper is converted into sulphide and more into sulphate and it therefore seems as if the two reactions indicated above take place simultaneously and the total reaction may be expressed :—

$$6Cu + 6H_2SO_4 = 4CuSO_4 + Cu_2S + SO_2 + 6H_2O$$

For the purpose of making sulphur dioxide it is usual to heat the reactants slowly by means of a rose burner and to withdraw the source of heat as soon as the gas comes off readily enough to be collected conveniently. This occurs between 130-170° C., and at these temperatures, according to Pickering[2], the total reactions take place in accordance with the complicated equations :—

$$11Cu + 16H_2SO_4 = Cu_2S + 9CuSO_4 + 6SO_2 + 16H_2O$$
$$24Cu + 42H_2SO_4 = Cu_2S + 22CuSO_4 + 19SO_2 + 42H_2O$$

Cundall[2] has since shown that cuprous sulphate, Cu_2SO_4, is also formed during the *interaction of copper and sulphuric acid.* According to him the reaction may be expressed by the following equations :—

$$8Cu + 4H_2SO_4 = 3Cu_2SO_4 + Cu_2S + 4H_2O$$
$$2Cu + 2H_2SO_4 = Cu_2SO_4 + 2H_2O + SO_2$$
$$5Cu_2SO_4 + 4H_2SO_4 = Cu_2S + 8CuSO_4 + 4H_2O$$
$$Cu_2S + 2H_2SO_4 = CuS + CuSO_4 + 2H_2O + SO_2$$
$$CuS + 4H_2SO_4 = CuSO_4 + 4SO_2 + 4H_2O$$

According to Fowles[3], there is no reason to complicate the reaction by assuming the intermediate formation of cuprous sulphide. In support of this Fowles has shown that when cuprous chloride is heated with sulphuric acid, hydrogen chloride and sulphur *dioxide are simultaneously evolved without* the formation of sulphide,

$$2CuCl + H_2SO_4 = Cu_2SO_4 + 2HCl$$
$$Cu_2SO_4 + 2H_2SO_4 = 2CuSO_4 + SO_2 + 2H_2O$$

In a private communication Fowles states *that he has found that cuprous sulphate is* produced when 80-98 per cent. sulphuric acid acts on copper. Its formation may be shown by heating sulphuric acid with excess of copper (as in making cuprous chloride) until sulphur dioxide has briskly evolved for a few minutes, then pouring a few c.c. of the hot liquid into a large flask of water. The contents of the flask often remain clear for a few *seconds, then a precipitate of red col*loidal copper suddenly appears throughout the mass

$$Cu_2SO = Cu + CuSO_4$$

Maumené[4] had earlier stated that in addition to sulphur dioxide and copper sulphate, *this interaction gave rise to cuprous* sulphide and three oxysulphides of copper to which he ascribed the formulæ, CuO, $2Cu_2S$; CuO, 2CuS and CuO. CuS. The evidence for the existence of these compounds is very slender. It is unusual for the percentages of copper and sulphur to total appreciably less than 100. They correspond closely to that required for Cu_2S, *namely,*

Cu	79.8 per cent.
S	20.2 ,, ,,

Incomplete drying or the presence of unremoved sulphate would account for Maumené's results. Fowles, however, has suggested that the presence of cuprous sul*phate or* its decomposition products would account for them equally well.

That the black substance is not copper oxide can be readily demonstrated by its insolubility in hot dilute sulphuric acid. Treatment with hot dilute nitric acid readily dissolves it with the formation of some free *sulphur and some sulphuric acid* as well as copper nitrate. Prolonged heating with fairly strong hydrochloric acid effects dissolution with evolution of hydrogen sulphide :—

$$Cu_2S + 2HCl = Cu_2Cl_2 + H_2S$$

If the solution be poured into excess of water the insoluble cuprous chloride is precipitated.

This reaction has since been considered incidentally by Adie[6] and there was a polemic in America between Andrews[7] and Baskerville[8] regarding the temperature of the reaction. Baskerville contended that sulphur dioxide was slowly evolved at ordinary temperature but Andrews held that below 86° C.
there was no reduction of sulphuric acid

If a stream of dry nitrogen be passed through a flask containing concentrated sulphuric acid and copper and then through a few c.c.s. of centinormal potassium permanganate solution this would be decolourised after several hours, whilst the acid assumes a brown colour. It thus appears that a slight action does take place even at ordinary temperatures. More recently still Rogers[9] has re-invested the reaction. He supposes that the first action is the formation of cuprous sulphide by the direct attack of the copper on the acid, and that the production of sulphur-dioxide is wholly due to the subsequent decomposition of the sul*phuric acid by the cuprous sulphide.* He makes no reference to cuprous sulphate.

Roger's equations are :—

$$Cu_2S + 2H_2SO_4 = CuS + CuSO_4 + SO_2 + 2H_2O$$
$$CuS + 2H_2SO_4 = CuSO_4 + SO_2 + S + 2H_2O$$
$$S + 2H_2SO_4 = 3SO_2 + 2H_2O$$

As Fowles has suggested, Rogers seems to have considered that the changes in the solid phases gave an adequate indication of the course of the reaction and to have overlooked the possibility of far more rapid

changes going on in such a reactive medium as the hot acid solution affords.

Free sulphur also occasionally appears in the neck of the reaction flask as a product of the interaction. It arises presumably as Rogers has indicated but is usually acted upon at once by the hot sulphuric acid with the liberation of more sulphur dioxide.

There is evidently still much confusion regarding the reactions involved for Cundall considered that the primary reactions were represented by the complicated equations

$$(a)\quad 8Cu + 4H_2SO_4 = 3Cu_2SO_4 + Cu_2S + 4H_2O$$
$$(b)\quad 2Cu + 2H_2SO_4 = Cu_2SO_4 + SO_2 + 2H_2O$$

Equation (*a*) was considered a "low temperature" equation yet it can be shown that sulphur dioxide is evolved (in very small amounts it is true) even at room temperature (vide, Baskerville, *loc. cit.*) Rogers, on the other hand, regards the primary reaction as following the equation :

$$5Cu + 4H_2SO_4 = Cu_2S + 3CuSO_4 + 4H_2O$$

The sulphur dioxide is supposed to originate by a series of secondary reactions, chiefly through the action of the sulphuric acid on the cuprous sulphide, involving the intermediate formation of cupric sulphide and sulphur but not cuprous sulphate. It would seem that many of the equations, especially those introduced by the earlier workers, are superfluous and are based not upon quantitative experiments but on the mathematical necessity of seeing that both sides of the equation balance! Thus Cundall, whose primary equations suggest the formation of considerable amounts of cuprous sulphate, obtained from 0.03 to 0.22 gram of copper on pouring his preparations containing cuprous sulphate into water in order to bring about the decomposition

$$Cu_2SO_4 = CuSO_4 + Cu$$

He states that the weights of the precipitate were small, and could not be materially increased by increasing the amount of the acting substances or the time of action. Cundall employed excess of sulphuric acid. On heating together copper and concentrated sulphuric acid in the proportion of 1 : 2, sulphur dioxide is evolved briskly as soon as the temperature reaches 130-170° C. Some sulphur is also liberated and there remains in the reaction flask a black residue. When this black residue is cooled and extracted with water its weight is very considerably diminished whilst the anhydrous copper sulphate goes into solution. The bulk of the residue (apart from any undissolved copper) is cuprous sulphide for on analysis its composition corresponds closely with that demanded by the formula for this compound. Roughly about six times as much crystalline copper sulphate (or nearly four times as much anhydrous salt) is produced as black insoluble residue remains. This points to the accuracy of the equation

$$6Cu + 6H_2SO_4 = 4CuSO_4 + Cu_2S + SO_2 + 6H_2O$$

as representing the main reaction at a temperature of 130-170° C.

When excess of concentrated sulphuric acid is used and a temperature of 270° C. employed, sulphur dioxide is very rapidly evolved and an almost colourless solution results (except for the deposition of anhydrou micro-crystals of cupric sulphate), in which case the first equation holds.

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These authors represent CuO as an intermediate product but do not actually state that it constitutes the black sludge.

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* Fowles criticises an article of mine in the previous number, p. 25; he was unaware that it was written before Rogers' paper was published. I passed proofs 15 months before publication.

A BRIEF REVIEW OF THE PRINCIPAL BASE METAL AND BASE MINERAL RESOURCES OF THE UNION OF SOUTH AFRICA.

By C. J. N. Jourdan.

(Paper presented to the Empire Mining and Metallurgical Congress, Montreal, August, 1927. Contributed by Permission of the Hon. the Minister for Mines and Industries.)

Journal of the Chemical, Metallurgical and Mining Society of South Africa.

(Continued from page 69.)

The asbestos-bearing field, being as such lineal dimensions, one expects that there might be some variation in the fibre itself and also in its chemical analysis. This suggestion might be regarded as receiving support from the fact that there is some variation in the physical appearance of the asbestos fibre, for while the fibre from the south end of the field is hard and stiff, being locally named " spyker draad," *i.e.*, " wire nail," yet it teases out into beautiful thread of great tensile strength, on the other hand the fibre from Kuruman is softer with a silky lustrous appearance. Around Danielskuil, midway between Prieska and Kuruman, the fibre assumes an intermediate physical appearance between the fibres described above. The Pietersburg, Transvaal, fibre again is quite different from any of that from the Cape Province, being more broken, though it is stated that it is improving in this respect as the workings get in under cover in the mountain side.

With the object of determining whether there is any great variation in the chemical analyses of crocidolite from different parts of the tremendous lineal extension over which the asbestos is distributed, the writer selected eight samples which seemed to differ from each other so far as external appearance seemed to indicate :—

No. 1 was of a dark blue colour and teased easily into soft silky fibre.

No. 2 was a light blue colour not so silky in appearance, though the fibres were sound.

No. 3 was a light blue colour, not so silky in appearance, and the fibres somewhat broken.

No. 4 was even more blue than No. 1, and the fibres were stronger, but teased out beautifully.

No. 5 was somewhat similar to No. 1.

No. 6 was similar to No. 2, but more silky in appearance.

No. 7 was a typical " spyker draad " of a dark blue colour and teased into beautiful silky fibre.

No. 8 was something between No. 7 and No. 1.

Nos. 5, 7 and 8 samples were taken from the Hay and Herbert Districts; Nos. 1 and 4 from the southern end of Kuruman District, and Nos. 2 and 6, sixty and thirty miles respectively north of Kuruman, while No. 3 came from the Pietersburg District.

Mark No.	1.	2.	3.	4.	5.	6.	7.	8.
SiO_2	52.30	54.50	59.40	52.90	52.60	50.50	50.65	52.85
Al_2O_3	—	—	—	—	—	—	—	2.00
Fe_2O_3	17.50	21.00	14.40	17.10	17.75	20.20	18.55	17.10
FeO	17.30	13.10	15.10	16.40	18.70	15.40	17.85	18.00
MgO	4.25	2.85	3.40	4.55	2.80	3.65	2.30	1.75
CaO	0.80	0.90	0.55	0.65	0.85	0.80	0.75	0.85
Na_2O	4.55	4.05	4.05	3.90	4.40	4.40	5.70	4.90
H_2O	3.00	2.90	3.25	3.90	3.20	4.15	3.70	2.55
Combn'd Moisture	0.80	1.05	0.10	0.45	0.30	1.05	0.80	0.70
	100.50	100.35	100.25	99.85	100.10	100.15	100.30	100.70

These analyses were made by Dr. McCrae at the Government Laboratory in Johannesburg, who remarks, *inter alia*, that the cleanest fibres of each specimen were selected for analyses, while the values given for combined water are actually determined values of the water evolved on heating strongly after the specimen had been dried at 100° C., they are not " loss on ignition " values.

Amosite—a grey ferrous silicate hornblende—occurs also in the base of the Pretoria series in the Pietersburg and Lydenburg Districts of the Transvaal between Penge and Chunies Poort, a distance of 60 miles. It is also a variety peculiar to South Africa, and is called after the initial letters of the mining company that first exploited it—the Asbestos Mines of South Africa.

Amosite is of considerably longer average

fibre than any other asbestiform mineral, lengths from 4 to 7 inches are so frequent as to render available continuous supplies of this length, all of which is spinnable.

The mineral possesses many of the combined properties of chrysotile and crocidolite, but it is the properties of the latter that it most closely resembles.

The mineral is gradually becoming known in the European and American markets, and the output from South Africa is steadily improving in quality.

If sweetened with a percentage of select fibre amosite spins well, and its comparative cheapness makes it a very suitable material for packing and filling purposes generally.

The fibre is cut at the mine works in 2 or 2½ inch lengths, and the low grade and waste products of that and lesser lengths are used in the manufacture of mill board by the Wilson process, a patent process discovered and evolved in South Africa. This process permits of the use of long fibre, as well as short, as against the older process which used only short fibre of less than spinning length; board manufactured by this process is thus not only more tensile than that made by the older process, but it can also be bent more readily without damage resulting, being more flexible.

Most of the country is rough and unprospected, but there is much reason to think that payable occurrences other than those now being developed might be opened up and that immense tonnages of amosite are available.

CORUNDUM.

The corundum fields of the Union of South Africa are the most extensive and richest in the world, occupying some 2,000 square miles in the Pietersburg and Zoutpansburg Districts of the Transvaal.

All the corundum is of the common variety. No occurrence of gem corundum worth following up has hitherto been discovered.

Corundum is produced from three forms of deposits, *viz.*, crystal corundum, boulder corundum, and reef corundum.

The crystal corundum consists of more or less broken crystals found in eluvial deposits having been weathered out of and concentrated from the corundum-bearing reefs. It is from these sources that nearly all the corundum has been produced which has hitherto been exported from the Union.

Boulder corundum is the name given to aggregations of corundum crystals embedded in a plagioclase matrix. These masses or blocks, which are very resistant to weathering action, vary from the size of a man's fist to several cubic feet.

Reef corundum occurs in veins intrusive into the basic rocks, which in turn occur in the granites and gneisses which predominate throughout the corundum fields. The corundum-bearing veins or reefs are highly felspathic plumasite bodies carrying crystals of corundum of varying percentage, sometimes as high as 90 per cent., but frequently as high as 45 per cent.

It is from reefs of this nature that the crystal and boulder corundum mentioned above has been weathered and concentrated eluvially.

Crystal corundum is recovered from eluvial deposits by open cast workings. The gravels are concentrated by sieving, and the cleaned gravels are concentrated in ordinary rotary pans to recover the corundum. The whole method is very primitive, but quite suitable for the purpose.

These eluvial deposits of corundum-bearing gravels occur scattered throughout the area of 2,000 square miles, and it is impossible to form any estimate of the quantity available from this source of supply. Most persons competent to judge are of opinion that is is very considerable, but, nevertheless, the deposits near the railway and trunk roads are gradually giving out, and operations are gradually shifting farther afield.

The following is a typical analysis of crystal corundum as exported from the Union :—

	Per cent.
Al_2O_3	94.51
SiO_2	1,54
Fe_2O_3	1.23
TiO_2	0.02
H_2O Combined	2.70
Total	100.00

Boulder corundum was exported during the Great War to quite a considerable extent, but it is not popular in the markets principally for the reason, one would imagine, that from the very nature of the material it is not possible to estimate the corundum content with the consequent result that in every consignment a very large amount of waste material is carried. There are, however, signs of increasing demand again for, it is said, refractory purposes.

Of reef corundum the supplies might correctly be described as unlimited. Every occurrence of eluvial crystal corundum, if followed down, will probably turn into reef.

A beginning has been made at Bandolierkop, a point on the railway system, in the production of grain corundum. The process of producing grain from reef might be described as an anticipation of the weathering action of Nature. The reef is mined in several localities near the plant, where it is crushed in Gates crushers to a suitable size and further reduced by stamps to be concentrated finally by jigs and tables preparatory to drying and grading according to size by a plant designed for that purpose.

A number of grades varying from size 8 to 200 and of very high alumina content have been produced and exported. Such users who have so far taken to it have expressed themselves as satified.

The corundum fields of the Union unquestionably hold out immense possibilities. The country has entered an era which we hope will show great industrial development. Immense strides are being made in the production of cheap electricity by modern power stations. It is, therefore, not unreasonable to think of an abrasives industry for the Union using corundum as its base.

If the production and grading of corundum grain and the manufacture of finished articles from the grain received the same attention that carborundum has received, for instance, then one might reasonably expect that it will be found to be suitable as an abrasive for a very large range of abrasive tools and for all manner of utility articles.

The immense resources of the Union in the material encourage one to think hopefully of the possibilities which this mineral offers.

Fluorspar.

Some fluorspar of very great purity occurs in the dolomites of the Transvaal System in the Marico District of the Western Transvaal.

The occurrences, of which two or three have been proved to be large enough to permit of exploitation, consist of pipe-like ore bodies owing their origin probably to some geyser-like action.

The production of fluorspar is not high, and will probably be maintained for some time to come.

Kaolin.

There are in South Africa important occurrences of kaolin of good quality. One such, near Cape Town on the Claremont Flats, is being opened up at the time of writing with the view of exporting the washed and treated product to the United States.

A small beginning has been made in the establishment of the ceramic industry in the cheaper lines.

At Grahamstown some magnificent art pottery has been made, and that by amateurs, which illustrate clearly that the raw materials for the ceramic industry are not wanting.

There is reason to think that there is a sufficiency of supplies of raw materials to put this and allied industries on a sound footing.

Magnesite.

There is quite an important occurrence of magnesite on the railway near Kaapmuiden in the Barberton District of the Transvaal. It is being worked on a small scale for home consumption only. Much of the mineral is pure white, is fairly hard, and has a specific gravity of 2.05.

The deposit lies in the Jamestown Series of schists and shales of the Transvaal System.

A very pure sample gives the following analysis :—

	Per cent.
MgO	45.27
CO_2	49.80
SiO_2	2.30
CaO	—
Fe_2O_3	0.80
Moisture	0.16
Total	98.33

Calculated as Minerals.

	Per cent.
Magnesite	97.75
Quartz	1.65
Haematite	0.21
Ferric Hydrate	0.50
Total	100.11

Mica.

Numerous workable deposits of muscovite mica occur in pegmatites intrusive in the old granites and gneisses along the Olifants River in the Pietersburg District of the Transvaal.

The mica-bearing belt is some five to eight miles wide and fifty miles long, and is served by a railway which cuts it somewhat to the west of its centre and brings it within easy reach of the port of Delagoa Bay.

Water is a problem in that section of the fields which is removed some distance from the Olifants River, and there is, also, some risk of malaria. Mica mining, however, is an industry that does not require much water, and arrangements can be made for domestic requirements. In so far as malaria is concerned, good houses, mosquito screened, and decent living, will make the conditions of life in the sub-tropical climate comfortable and healthy.

The mica occurs in pockets scattered throughout the pegmatite. The pockets are sometimes of considerable size, running occasionally into cubic yards, which contain numbers of "books" or mica which, when trimmed up, yield sheets of mica of excellent quality.

Much of the mica which has been opened up so far in these fields is of a pale olive green colour.

Some of the occurrences, however, yield a pale brown mica, and others a nearly colourless product.

Considering its extent and resources the field may be said to be practically untouched. A few occurrences have been worked in a small way, but for want of organisation in mining, dressing, and marketing it has not so far yielded any great quantity of mica. The waste or scrap mica of the pale green variety is beginning to enjoy much popularity among mica grinders, the product being a very fine, lustrous one.

There seem to be good reasons for thinking that if this field, with its many occurrences of mica, were explored and developed it will yield many of the different classes of grades of mica demanded by different industries which use it.

TALC.

There are numerous occurrences of talc also, as in the case of chrysolite and magnesite, in the Jamestown Series of the Transvaal System. The best development that have hitherto been opened up lie in the same locality as the magnesite near Kaapmuiden Railway Station, in the Barberton District, some 93 miles from the port of Delagoa Bay.

Machinery for the treatment and grinding of talc has just been erected for the first time in South Africa, and production has started; the ground product is said to be of excellent quality. The tonnage available from this source of supply is very considerable.

The following is a typical analysis :—

	Per cent.
Silica	63.10
Magnesia	32.40
Iron Oxide	1.26
Soda	0.33
Water	2.91
Total	100.00

The above review has been limited to those minerals which occur in such quantity and are of such quality as to suggest that they hold out commercial possibilities.

Certain other minerals, however, also occur, though on a smaller scale, these being arsenic, bismuth, graphite, iron pyrites, lead, iron-oxides, ochres, osmiridium, scheelite, soda, tungsten, vanadium, and zinc. Some of these are even worked in a small way.

The financial resources of the Union have not so far permitted of the completion of the geological survey of the whole country, but considerable tracts have been so surveyed and these are constantly being added to by a small but efficient staff.

GENERAL NOTES.

KODAK INVENTOR SUGGESTS CALENDAR CHANGE.

That business could be run with less money and turnover increased by a change of calendar is the opinion of Mr. George Eastman, the founder of the Kodak Company. Mr. Eastman argues that business would benefit by a substitution for the present calendar of one of thirteen months—each of four equal weeks—because there would be thirteen monthly settlements during the year instead of twelve and consequently a faster turnover. The same volume of business could be handled with less capital.

Easter could be fixed with benefit to certain businesses. All months would be comparable without adjustments being made for unequal number of days or weeks, and a great amount of clerical work would be eliminated in the preparation of amounts and statistical reports.

Lapse of time for interest and other purposes could be calculated more easily, and a month of exactly four weeks would obviate many of the adjustments now necessary between four and five-week months. Also, every month-end would coincide with the

week-end most convenient for business, rents, and general affairs. Fractions of weeks at month-ends would cease.

The scheme would mean thirteen months, each of twenty-eight days. The first of the month would fall on a Sunday, and one would be able to tell the days of the week by the date. An extra month, called "Sol," would be inserted between June and July, and the odd day in the year would be called "Year Day."

It is estimated that thirteen monthly settlements instead of twelve would mean that two billion more dollars would be available for business expansion in Europe and five billions for the world.

American business men are said to be almost unanimous in favour of the new calendar. A questionnaire sent to 1,000 of the leading firms brought favourable replies in almost every case. Mr. Eastman recently called at White House to discuss the plan with President Coolidge.

FIRE WITHOUT SMOKE.

Campaign Against Air Pollution in the Great Cities.

A Lord Mayor's Lead.

Following on the passage into law last year of the Public Health (Smoke Abatement) Bill, real efforts are at last being made to tackle the smoke problem of our great cities.

The Act provides for the appointment of regional committees for the purpose of enabling local authorities to take co-ordinated action over wide areas against smoke pollution. Under the auspices of the Coal Smoke Abatement Committee of London, working in conjunction with the Smoke Abatement League of Great Britain, a conference has been arranged to take place at the Manchester Town Hall on March 8 at which practical stages for the carrying out of the provisions of the Act will be discussed. It is hoped that Sir Napier Shaw, the well-known meteorologist, who is president of the League, will preside.

Simultaneously, several Northern cities are seriously concerning themselves with the smoke pollution from domestic chimneys which, though not dealt with in the Act, is held by experts to be responsible for the greater part of Britain's vast output of atmospheric soot and dirt. The Manchester Public Health Department is pursuing investigations with various forms of smokeless domestic fuel, with a view to making recommendations for the reduction of raw coal burning, while at the Sheffield Town Hall experiments were recently made in order to test the possibilities of the residual fuel of low temperature carbonisation of coal, which has recently been established on a commercial basis at Barugh, near Barnsley.

Sheffield and Rotherham have formed the first Joint Regional Smoke Abatement Committee under the new Act, and the chairman (Councillor W. Astbury), reporting on a recent test made over a period of three days in an ordinary domestic Yorkshire range, with coalite, the low temperature carbonisation residual fuel, summarises the results as follows:—

(1) Much cleaner than coal in every way.
(2) Gives greater heat than the best house coal.
(3) More economical, lasting longer and waste content negligible.
(4) No smoke.

The Co-operative Society in Sheffield is recommending its 50,000 members to assist in the prevention of smoke pollution from domestic chimneys by burning low temperature fuel, and seventy branches are assisting in the distribution of this fuel. The chairman of the Health Committee has appealed to all citizens to burn smokeless fuel, and, in company with the Lord Mayor and the Medical Officer of Health, he is setting a personal example to the citizens.

UNITED STATES AUTOMOBILE MANUFACTURERS TO DEVELOP BRITISH COLUMBIA CHROMIUM DEPOSIT.

The Arctic chromium deposits on the Bonaparte River, 23 miles north of Ashcroft, British Columbia, have been acquired by Detroit automobile manufacturing interests, represented by Mr. Charles C. Bush, of the Ford Building, Detroit. The property was owned by Mr. A. C. Cooper, of Victoria, and Mr. Charles F. Law, of Vancouver. Staked by these men years ago, it was worked by the Imperial Munitions Board during the war, when chromium was in great demand. Mr. Bush obtained the property by a sales agreement over offers by General Motors and the Consolidated Mining and Smelting Company of Canada. Chromium is becoming an in-

creasingly important metal in industry and is now being used in the automobile industry as a substitute for nickel.

NOVA SCOTIA BLAST FURNACES CREATE NEW RECORDS.

All production records of the Dominion Iron and Steel Company were broken by blast furnaces Nos. 1 and 4 during December. No. 1 furnace produced a daily average of 514.7 tons of iron, as against the best previous high output of 490 tons attained earlier in 1927, while No. 4 blast furnace turned out a daily output of 351.4 tons, which is ten tons a day better than any previous mark. The output of No. 1 furnace was about 25 per cent. higher than in 1924, which was also a high production period.

INSTITUTE OF METALS.—TWENTIETH ANNUAL MEETING.

OPENING OF NEW OFFICES.

The twentieth Annual General Meeting of the Institute of Metals, which will be held in London on March 7 and 8, at the Institution of Mechanical Engineers, Storey's Gate, Westminster, will include several interesting functions. Thus the new President, Dr. W. Rosenhain, F.R.S., will be inducted into the chair by Sir John Dewrance, K.B.E., and will deliver his Presidential Address. Afterwards sixteen papers will be read and discussed. These include contributions from metallurgists in Germany, Japan and the United States, as well as Great Britain. Following the papers, there will be a dinner and dance at the Trocadero Restaurant, also the formal opening of the new offices and library of the Institute, at 36, Victoria Street, London, S.W.1. The official programme of the Meeting includes a notable list of new Members—123 in all—which brings the Membership close to the 2,000 mark. It is striking to note what a large proportion of the new Members reside abroad. An election of Members is announced to take place on February 22; particulars of Membership, which now covers the period ending June 30, 1929, are obtained from the Secretary, Mr. G. Shaw Scott, M.Sc., 36, Victoria Street, London, S.W.1. Among the latest applicants for membership are M. André Citroën, the famous French motor car maker, and representatives of the French Mint and Ministry of Marine.

ANALYSIS OF FERTILISERS.

The Council of the Institute of Chemistry, after careful consideration of the whole of the circumstances, has drawn up the following proposals with regard to the remuneration, under the new Act, of those Official Agricultural Analysts, who are paid by fee per sample, feeling that in so doing they will have helped to give guidance to local authorities as to the fees that will be generally regarded by the chemical profession as fair and reasonable. It will be seen that in this scale, regard has been had to the fact that the extent of information required in an analysis varies according to the commodity.

The scale recommended is as follows:

(1) For analysis of a fertiliser or feeding stuff where the determination of a single item only is required—not less than £1 1s. 0d. per sample.

(2) Where a determination of two separate items is required—not less than £1 11s. 6d. per sample.

(3) For fuller examination, according to the complexity of the analysis required—£2 2s. 0d. to £3 3s. 0d. per sample.

(4) In cases where the number of samples is likely to be small and a "flat rate" is preferred by the Local Authority, the all-round fee should be £2 2s. per sample.

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.

The following papers were read at the meeting held on January 26, 1928:—

The Interchange of Electricity Between Thunderclouds and the Earth. By B. F. J. SCHONLAND. Communicated by C. T. R. Wilson F.R.S.

Observations were made to examine the part played by (*a*) point-discharge currents, (*b*) lightning discharges between cloud and ground, and (*c*) charged rain, in the electrical interchange between an active thundercloud and the earth. From these observations, (*a*) and (*b*) are estimated to produce continuous currents of the order of 2.1 and 0.1 (equivalent) amperes respectively, in an upward direction, and (*c*) to produce a reverse downward current of the order of 0.2 amp. The resultant current is thus estimated at 2.2 amps, in such a direction as to convey a negative charge to earth.

The Thermal Conductivities of Oxygen and Nitrogen. By H. GREGORY AND S. MARSHALL. Communicated by H. L. Callendar, F.R.S.

The thermal conductivities of these gases at 0° C. are investigated. The apparatus used was the vertical compensated hot-wire type employed by the authors in their determination of the thermal conductivity of carbon dioxide.

The object was to confirm the result obtained by Gregory and Archer for air, on account of the wide discrepancy which exists among results obtained for conductivity of this medium by various observers.

Procedure was same as in case of investigation of CO_2, except that an alternative method was used for determining fundamental intervals of platinum wires, a problem approached from point of view of thermal conduction through the gas.

The results are given as 589 × 10^{-7} cal. cm.$^{-1}$ sec.$^{-1}$ deg.$^{-1}$ for oxygen, and 580 × 10^{-7} cal cm.$^{-1}$ sec.$^{-1}$ deg.$^{-1}$ for nitrogen, at 0° C., and are consistent with those of Gregory and Archer for the thermal conductivity of airat 0° C.

On a Method of Determining the State of Polarity of Downcoming Wireless Waves. By E. V. APPLETON, F.R.S., AND J. A. RATCLIFFE.

Recent observations on the effects of the atmospheric ionised layer on wireless transmission have shown that downcoming wireless waves of 300-500 metres wave-length possess components of electric force both in and at right angles to the plane of propagation,, but information on the precise nature of the polarisation has been lacking. The paper describes the results of experiments, using a method of determining the polarisation constants of ellipticity of such waves. For down-coming waves of 400 metres wave-length in England the polarisation is found to be approximately circular with a right-handed sense of rotation. In attempting to account for these results it is pointed out that, according to the magneto-ionic theory of atmospheric deflection of wireless waves, in which the influence of the earth's magnetic field is taken into account, such right-handed elliptical polarisation might be expected if the effective electrical carriers are of electronic mass.

On the Measurement of the Specific Heat of Aniline with Temperature, Using the Continuous-Flow Electric Method. By H. R. LANG. Communicated by H. L. Callendar, F.R.S.

New experiments on variation of specific heat of aniline with temperature have been carried out by the continuous-flaw electrical method. Experimental details are described and possible sources of error investigated. Two types of flow calorimeter were used, giving results in close agreement, although in one case a convection correction had to be applied. Care was exercised to use only pure aniline. It was found extremely difficult to get the liquid perfectly dry, as it was hygroscopic. The very small water-content was determined in each case from the freezing-point. A separate investigation gave relation between water-content and freezing-point, a small correction being applied to give value for perfectly dry aniline.

Between 5° and 75° C. rate of change of specific heat with temp. was found to increase with rising temp. Experiments were also performed at temps. below 5° C., bnt owing to rapid increase of viscosity, values are rendered less certain in this region.

An X-ray Study of Some Simple Derivatives of Ethane. Part I. By K. YARDLEY. Communicated by Sir William Bragg, F.R.S.

The substances C_2Cl_6, C_2Br_6, $C_2Cl_4Br_2$ (two forms), C_2Br_5F, $C_2Cl_3Br_3$, $C_2Br_4(CH_3)_2$ (two forms), form an isomorphous series, crystallising in the space-group Q_h^{16}. The unit-cell contains four plano-symmetrical molecules. Two halogen atoms and the two carbon atoms lie in the symmetry plane (010). The molecules of C_2Cl_6, C_2Br_6 and $C_2Br_4(CH_3)_2$ also possess a pseudo-centre which produces additional halvings not expected from space-group considerations.

From the molecular symmetry the symmetry of the carbon valencies is deduced and it is shown that the carbon atom possesses two A and two B valencies, possibly identical with the two (2, 1) and two (2, 2) electrons in the outer group of neutral carbon.

Composite F curves obtained for C_2Cl_6 and C_2Br_6 are compared with Hartree's curves for Cl- and C^{4}+. The formula of both forms of $C_2Cl_4Br_2$ appears to be CCl_3. $CClBr_2$. The two CH_3 groups in $C_2Br_4(CH_3)_2$ lie in the symmetry plane.

THE CHEMICAL SOCIETY.

Papers read on Thursday, February 2 :—

Some Experiments on Diffusion in Solid Metals. By J. W. JENKIN AND C. H. DESCH.

The two metallic systems examined were copper-nickel and copper-zinc. Smooth, rectangular specimens of the one metal were coated electrolytically with the other metal, and the progress of diffusion was measured by cutting sections after definite periods at a given temperature and observing by means of the microscope. The phases of the copper-zinc system are sufficiently distinguished by colour, whilst the copper-nickel alloys have to be etched and compared with a trial plate made by clamping together a series of alloys of progressively varying composition, and comparing the distance to which etching proceeds under given conditions. The observed diffusion curve is the resultant of two curves of similar mathematical form representing diffusion in two opposite directions, and it is possible to arrive at approximate values for the two coefficients. Thus the diffusion of copper into nickel is about twenty times as rapid as that of nickel into copper. In the brasses, the production of a sharp boundary accompanies the formation of an intermetallic compound. A difference of 25 per cent. in the concentration of the outer and inner portions of a cored crystal of cupro-nickel has been determined to exist as the result of incomplete diffusion during solidification.

The Alkaloids of Some Indian Aconites: Aconitum rotundifolium, A. Balfourii, and A. deinorrhizum. By T. A. HENRY AND T. M. SHARP.

The alkaloid present in *A. rotundifolium* is an acetylbenzoylaconite, possibly identical with japaconitine or aconitine.

Pseudoaconitine occurs in *A. Balfourii*, as in *A. deinorrhizum*. A long series of salts has been prepared and the functions of all the oxygen atoms have been determined. With the additional information now available, the empirical formula, $C_{36}H_{51}O_{12}N$, of pseudoaconitine can be expanded as follows :—

$$C_{20}H_{22}(NCH_3)(OH)_2(OCH_3)_4(O.CO.CH_3)$$
$$(O.CO.C_6H_3(OCH_3)_2).$$

On oxidiation by chromic acid, it is converted into a well-crystallised substance, $C_{34}H_{45}O_{11}N$, which is basic in character, and on hydrolysis yields acetic and veratric acids and a new base, $C_{23}H_{38}O_7N$; it contains one methoxyl group less than the parent alkaloid, but retains the methylimino-group of the latter.

The Synthesis of meso-Alkyl and meso-Aryl Anthracene Derivatives. Part III. By E. de B BARNETT AND J. W. COOK.

The action of Grignard solutions on 1 : dichloro-9-benzylanthrone, 9 : 9-diphenylanthrone and 9 : 9-dibenzylanthrone has been examined. The resulting dihydroanthranols have usually given methylene derivatives on dehydration, although in two cases transannular loss of water was effected. The facile production of methylene derivatives from compounds obtained by the action of magnesium alkyl halides on diphenylanthrone renders it improbable that the formation of methylene compounds in other cases is due to a transannular migration of hydrogen under the influence of hydrogen ions. Previous indications that an alkyldihydroanthranol can undergo transannular loss of an alcohol have now received confirmation by the formation of 9 : 10-dibenzylanthracene from 9 : : 10-tribenzyldihydroanthranol.

Treatment of 1 : 5-dichloranthrone with benzyl chloride and potassium hydroxide yielded 1 : 5-dichloro-8-benzylanthrone (which could not be acetylated or methylated), whereas 1-chloro-9-anthrone, like anthrone itself, readily yielded a dibenzyl compound. The inhibiting effect of the *a*-chlorine atoms appears to be a general phenomenon in connection with the reactions of 1 : 5-dichloroanthracene and its derivatives.

SOCIETY OF GLASS TECHNOLOGY.

The first meeting of the Society of Glass Technology for the year 1928 was held in the College of Technology, Manchester, on Wednesday, January 18, the President, Walter Butterworth, Senr., in the chair.

Discussions took place on the following subjects :—

The Design and Operation of Glass Furnaces.

The discussion on this subject was introduced by Mr. W. M. Warren, A.M.I.C.E., A.M.I.E.E., who compared a boiler plant with a glass furnace system. The most important development in boiler plant had been the substitution of the Lancashire boiler by the water tube boiler. The latter had a high rate of heat transmission and a

high maximum temperature in the combustion chamber. Waste heat boilers had been adopted in Germany. With one tank furnace only, the only fault in a waste-heat boiler was that there was not sufficient fuel and heat to keep the boiler going. The lagging of a furnace meant a higher temperature in the furnace, more rapid melting of batch and cullet, and a smaller melting area. A decreased melting area meant a decreased radiation loss. Furnaces should be as small a possible. In certain cases the German oval or coffin-shaped furnace with 8 pots was ideal; for pressed glass and heavier work the American 16-pot furnace was best. Reference was made to the use of two throats instead of one. A regenerative furnace yielded a higher temperature than a recuperative furnace, the litter could not recover the same amount of heat from the products of combustion as a regenerative furnace.

In conclusion, Mr. Warren referred to the extensive investigations of glass furnace operations carried out in Germany. A Committee of the Society of Glass Technology had recently been set up for the purpose of collecting data for furnaces in British factories. The courtesy and co-operation of manufacturers was invited for a frank interchange of ideas on all questions affecting furnace operation.

The Refining of Glass.

Prof. W. E. S. Turner referred briefly to the improvements which had taken place in glass melting operations during the last ten years. More had been accomplished by attention to melting operations than by the furnace builder. There had been a marked change in the type of glasses made, with an increased rate of melting. The glass could be drawn off more rapidly, thus reducing the fuel consumption due merely to temperature maintenance. Refining of the glass now took place before it passed the bridge. Further efficiency was obtained by thorough mixing of the batch and cullet. In order to hasten the melting and refining processes, any churning action was helpful, whether effected mechanically or by agents such as water vapour, arsenic or antimony. Since nearly all the arsenic used had been found to remain behind in the glass (and antimony might behave similarly to arsenic) it was difficult to say exactly what their action was. Other substances might well be used to promote the stirring of the glass. In this connection the effect of the addition of the volatile ammonium salts had been investigated. Additions of ammonium chloride, nitrate and sulphate were made to a batch in proportions ranging from 2 to 25 parts per 1,000 parts of sand. The time taken for the melt to become batch-free was noted in each case. It was found that the additions did speed up the melting and refining processes to a marked degree.

Mr. H. Hemingsway described results obtained at Queenboro' with two small tanks, one making a carbon-sulphur amber glass, the other a flint glass. The compositions of the glasses were approximately alike. It was found that with the amber glass, sulphur increased the rate of melting. From the flint tank it was possible with safety, to pull 1 ton of glass per 8 square feet per 24 hours. From the amber tank, considerably more, namely, 1 ton of glass per 6 square feet per 24 hours could be melted without unduly forcing the tank. Under pressure of production the amber tank could be made to deliver as much as 1 ton per 4½ square feet of melting area, and maintain this rate for several hours. At the Canning Town works it had been found that iron helped in the melting and refining of a pale green glass.

The Manufacture and Use of Glasshouse Pots. (A continuation of the Discussion on papers presented at the Stourbridge Meeting, November, 1927, by Prof. W. E. S. Turner and Mr. H .E. Edwards.)

Mr. P. Merson observed that poor results might sometimes be attributed to insufficient heating of the pots before putting them into use. The Stourbridge pot-clays did not reach maturity in resistance to corrosion unless soaked for a very long period at 1,300° C. It was essential that the clay portion of a pot should be fired either sufficiently long, or hard enough to sinter together with the grog, so that a tight impermeable bond resulted. For a direct-fired pot arch he recommended the building up of the inside wall of the fire boxes with open 4½ inch spaced checker work, right up to the crown of the arch. By doing this the heat generated in the fire box was better diffused through the arch, with the further advantage of better combustion and control in burning. He would like to call for support for the method of comparing pot service by the actual length of life, in conjunction with the number of foundings given, so that the value of either factor could be brought into consideration. With regard to the shot-holing of pots he could corroborate the remark that in some instances, around Stourbridge, shot-holing in the bottoms of pots was due to the action of metallic lead,

either originally present or subsequently reduced from the red lead in the melt. The formation of these metallic beads could be avoided by the use of sufficient nitrate or other oxidising agent. Shot-holing might occasionally be caused by the presence of iron nodules or by the accidental or careless contamination with foreign matters such as match stalks, nails and fibre. He favoured the moulding of pots against an internal wood core, as the clay could be well beaten and welded together. Siliceous clays required more heat than alaminous clays to bring about the dense structure which was consistent with good resistence to glass attack.

NOTICES OF BOOKS.

The British Journal Photographic Almanac, 1928. Ed.: GEORGE E. BROWN, F.I.C. 788 pages and 64 pages of photogravnre supplements. London, Henry Greenwood and Co., Ltd., 24, Wellington Street, W.C.2. 2s. net (paper covers); 3s. net (cloth bound).

The 1928 volume of the *British Journal Photographic Almanac* is a wonderful book, for it contains 788 pages and also 64 photogravure pictures, yet is sold for only 2s. Every camera user obtains endless hints on the ever-popular hobby. The latest new goods (cameras, lenses, plates and films, etc.) are reviewed in a way which provides unique guidance to the novice in the choice of requisites among the many makes advertised in the book. One article deals with important uses of photography; another, with the increasingly popular amateur cinematography; and a third with the making of the pleasing border portraits beloved of the professional. The gravure pictures, which themselves are worth the price of the book, are reproductions of notable pictorial photography from many countries.

The Epitome of Progress is probably the section which will be read with greatest immediate interest by chemists who are photographers. It summarises the year's advance and describes the latest apparatus and appliances which are at the disposal of the photographer. The formulæ and other useful data come later and are there for ready reference. There is also a whole collection of miscellaneons information of importance and a directory of photographic and kindred societies.

Mr. George E. Brown, the Editor of the *B. J.*, who has been responsible for the *Almanac* since 1906, is to be congratulated on the high level attained as well as for his own valuable and informative contribution.

J. G. F. D.

Chemistry of Water and Sewage Treatment. By ARTHUR M. BUSWELL, Professor of Sanitary Chemistry, University of Illinois. Pp. 362. Price $7. Book Dept., The Chemical Catalog Company, 419, Fourth Avenue, at 29th Street, New York City, U.S.A.

This is one of the American Chemical Society's useful monograph series, and it deals fully and scientifically with a subject of interest to everybody. Readers will remember that this series is the outcome of an arrangement with the Inter-Allied Conference of Pure and Applied Chemistry which met in London and Brussels in 1919. The series is produced under the supervision of a Board of Editors, the personnel of which are experts in the subjects embraced in the various monographs. In the present, one of the most interesting of the series, the author has presented all the latest information concerning the chemical reactions taking place in the processes used in the improvement of water for domestic and other uses, and by which sewage, etc., are rendered fit to be discharged into water courses. By means of numerous tables and figures, the various phases of the subject are scientifically explained, while there is an exhaustive bibliography of some thousands of references, so that readers can confer with works dealing with any particular points on which fuller information may be desired. The book is one that will prove most nseful to engineers and more particularly those concerned in water supplies and sanitary arrangements and investigations, but at the same time it is a work that will be read with pleasure and advantage by a large section of the educated public. In addition to the author index, there is a very full subject index, in alphabetical order, which considerably enhances the value of the work.

Chemical Affinity. By L. J. HUDDLESTON, M.C., B.Sc., A.I.C. (Lecturer in Physical and Inorganic Chemistry at the University College of Wales, Aberystwyth. Pp. VIII + 138. Price 7s. 6d. London: Longmans, Green & Company, Ltd., 39, Paternoster Row, E.C.4.

The present work aims at the development of the use of Thermal and Equilibria

Data "to assist in the design and control of new problems." The author fears that few young graduates could (for example) discover from the data of Baur, that although the hydrolysis of silicon tetraflouride by water vapour is increased when the temperature is raised. The work has been carefully thought out and written, and ought to prove very helpful to students who desire to gain a practical knowledge of the subjects dealt with by the author. There are six chapters: Energy and its Transformation; Entropy; Free Energy; Solutions; The Nernst Heat Theorem and Third Law of Thermodynamics; and Applications. These are followed by appendices, reference and subject and name indices.

FORTHCOMING EVENTS.

GEOLOGICAL SOCIETY OF LONDON.

The annual meeting will take place on Friday, February 17, at 3 p.m., at Burlington House, W.1. The Fellows and their friends will dine at the Criterion Restaurant, Piccadilly Circus, on the same evening, at 7.30 p.m.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

At the Royal Society of Arts Rooms, John Street, Adelphi, London.

Tuesday, February 14, at 5.30 p.m.

Tuesday, February 14, at 5.30 p.m.—"Causes of Fires in the Petroleum Industry and Methods of Prevention." By Christopher Dalley, M.Inst.P.T.

INSTITUTE OF METALS.

Scottish Local Section. At the Rooms of the Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow.

Monday, February 13, at 7.30 p.m.—"*Further Notes on Aluminium Alloys.*" By D. R. Tullis.

PEOPLE'S LEAGUE OF HEALTH.

Wednesday, February 15, at 6 p.m., at 11, Chandos Street, London, W.1.—"Thought and Memory," by Dr. Thomas Beaton, O.B.E.

THE ROYAL SOCIETY.

Burlington House, London, W.1.

Thursday, February 16, at 4.30 p.m.—A. Fowler, F.R.S., and E. W. H. Selywn: "The Arc Spectrum of Carbon." R. H. Fowler, F.R.S.: "The Chemical Constant of Hydrogen Vapour and the Failure of Nernst's Heat Theorem." A. H. Wilson: "The Ionised Hydrogen Molecule." (*Communicated by R. H. Fowler, F.R.S.*). A. H. Wilson: "A Generalised Spheroidal Wave Equation." (Communicated by R. H. Fowler, F.R.S.). O. H. Walters and S. Barratt: "The Alkaline Earth Halide Spectra and their Origin." (Communicated *by T. R. Morton, F.R.S.*). Several other papers will be read in title.

ROYAL MICROSCOPICAL SOCIETY.

20, Hanover Square, London.

Wednesday, February 15, at 7.30 p.m.—Mr. D. J. Scourfield, I.S.D., F.Z.S., F.L.S., F.R.M.S.: "A New Type of Aquarium Microscope." Professor J. T. Wilson, M.A., LL.D., F.R.S.: "*Description of a* Convenient Table for Microscopy."

ROYAL SOCIETY OF ARTS.

John Street, Adelphi, London.

Monday, February 13, at 8 p.m.—(Cantor Lecture). "Fatigue Phenomena, with Special Reference to Single Crystals." By H. Gough.

Wednesday, February 15, at 8 p.m.—"The Education of the Blind." By Sir Beachcroft Towse, V.C., C.B.E.

ROYAL INSTITUTION.

Albemarle Street, London.

Tuesday, February 14, at 5.15 p.m.—Prof. A. P. Newton: "The Dependent Empire and the British Commonwealth of Nations, 1870-1926."

Thursday, February 16, at 5.15 p.m.—Sir William Bragg: "From Faraday's Note Books."

Friday, February 17, at 9 p.m.—Rev. E. M. Walker: "The University: Its Ideals and its Problems."

Saturday, February 18, at 3 p.m.—Mr. H. C. Colles: "Musical London (1660-1759)."

SOCIETY OF CHEMICAL INDUSTRY.

Milton Hall, Deansgate Manchester.

Friday, February 17, at 7.30 p.m.—" An Examination of the Influence of Various Factors on the Products of Carbonisation of Coal." By H. H. Thomas, B.Sc.

SOCIETY OF DYERS & COLOURISTS.

At Milton Hall, Deansgate, Manchester.

Friday, February 17, at 7.30 p.m.—" The Standardisation of Fastness of Coloured Textiles." By F. Schofield, M.Sc., F.I.C.

SOCIETY OF GLASS TECHNOLOGY.

In Room C.4., The Applied Science Department, The University, St. George's Square, Sheffield.

Wednesday, February 15, at 2.30 p.m.—" The Analysis of Opal Glasses." By W. Singleton (General Electric Co., Ltd., Research Laboratories). " The Study of a Fundamental Reaction in Glass Making." By J. T. Howarth M.Sc., and Prof. W. E. S. Turner. " Note on the Ultro-Violet Ray Transmission of Colourless Bottle Glass." By David Starkie, M.Sc., and Prof. W. E. S. Turner.

THE ROYAL INSTITUTE OF PUBLIC HEALTH.

37, Russell Square, London, W.C.1.

Wednesday, February 15, at 4.30 p.m.—" Medico-Legal Aspects of Jewish Life." By W. M. Feldman, M.D. (Lond.).

UNIVERSITY COLLEGE.

Gower Place, W.C.1.

Monday, February 13, at 2 p.m.—" The German Hildensaga." A public lecture by Professor R. Friebsch.

At 5.30 p.m. — " George Meredith." First of a course of three lectures by Dr. E. A. Baker. Other lectures, February 20 and 27.

Tuesday, February 14, at 5.30 p.m.—" Some Practical Aspects of Sea Power, Diplomacy and Sea Law." First of a course of two public lectures by Maj.-Gen. Sir George Aston, K.C.B. Other lecture, February 21.

Thursday, February 16, at 5.30 p.m.—" Giovanni Berchet " (Italian), by Dr. Am. Bascom.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

1,827.—Bellay, J.—Production of hydrogen. January 19th.

1,442.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of condensation products of benzodiazine series. January 16th.

2,064.—Chemical Engineering and Wilton's Patent Furnace Co., Ltd.—Manufacture of sulphate of ammonia. January 21st.

1,421.—I. G. Farbenindustrie Akt.-Ges. —Production of nitric acid, etc. January 16th.

1,694.—I. G. Farbenindustrie Akt.-Ges. —Treatment of gases, etc. January 18th.

Specifications Published.

283,619.—Schindelmeiser, J. — Compositions of matter containing esters or ethers of carbohydrates.

283,650.—Simon, M. E., and O'Connor, J. A.—Electrical method and apparatus for identifying chemical elements and compounds and biological organisms.

283,701.—U.S. Industrial Alcohol Co.—Process for producing absolute alcohol.

283,702.—British Celanese, Ltd., Dreyfus, H., and Haney, C. I.—Treatment of lower aliphatic acids.

283,781.—Ruzicka, Dr. C.—Process for the production of acetic anhydride.

Abstract Published.

281,582.—Alkaloids. — Wellcome Foundation, Ltd., 67, Holborn Viaduct, Henry, T. A., and Sharp, T. M., 6, King Street, Snow Hill, both in London.

Alkaloids from the seeds of *Picralima Klaineana*, Pierre, are obtained and separated into three alkaloids referred to as A, B, and C. The ground seeds are freed from fat and extracted with ethyl alcohol. The extract is dried and again extracted with dilute hydrochloric acid, clarified with charcoal and filtered. If the filtrate is made alkaline with sodium carbonate the total precipitable alkaloids are obtained. If, however, the filtrate is first carefully diluted with water a portion of alkaloid A is then precipitated, and a further precipitate is then obtained by making alkaline. This precipitate can be separated into ether-soluble and ether-insoluble portions. From the ether-soluble portion alcohol dissolves out alkalond B and leaves alkaloid C, and the ether-insoluble portion is alkaloid A. The three alkaloids may be further purified by any of the ordinary processes.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

HAMATOPAN.

478,598.—Chemical substances prepared for use in medicine and pharmacy.—August Wolff, Sudbrackstrasse 183, Bielefeld, Germany. January 25th.

"PATCH AND PITCH."

486,222.—Chemical substances used in manufactures or philosophical reseach, and anti-corrosives.—Henning Orla Bruhn, 93, Store Kongensgade, Copenhagen, Denmark. January 25th.

DUROTEX.

485,328.—All goods in class 1 which includes *acids, potash, salts and other* chemical substances used in manufactures.—Arthur Sanderson and Sons, Limited, 52, 53, 54, and 55, Berners Street, London, W.1. January 25th.

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CONTENTS. PAGE.

Sodium Pyrophosphates	97
By Professor J. R. Partington and H. E. Watson.	
The Lead-Tin System of Alloys	100
By F. H. Jevery.	
Early Chemistry in Ireland	100
The Chemical Engineer	102
By Professor E. C. Williams	
Research on Sulphonated Oils	102
By Ukinziro Winokuti.	
General Notes	103
Pulverised Fuels	103
Low Temperature Carbonisation	104
Proceedings & Notices of Societies:—	
Society of Public Analysts	107
Notices of Books	109
Forthcoming Events	110
New Patents	111
New Trade Marks	112

NEW COAL FIELD.

A valuable coal field has been discovered in Madagasgar, with approximately 1,000 million tons available, the quality being of the medium kind.

ROYAL SANITARY INSTITUTE.

We are reminded that the annual Congress is to be held at Plymouth from 16 to 31 July next.

TO INVESTIGATE THE GREAT BARRIER REEF.

Under the leadership of Dr. C. M. Young, of Plymouth, a party of British scientists are to visit the Great Barrier Reef, 1,200 miles long (Queensland) later on this year to study the economic biology of the Reef.

SODIUM PYROPHOSPHATES.

By PROF. J. R. PARTINGTON AND MR. H. E. WALLSOM.

It is usually stated (*e.g.*, Abegg, *Anorg. Chem.*, III, 3, 445), that only two series of salts of pyrophosphoric acid exist, *viz.*, $M_4P_2O_7$ and $M_2H_2P_2O_7$. The salts $Na_3HP_2O_7$ and $NaH_3P_2O_7$ have, however, been described. T. Salzer (*Archiv der Pharmacie*, 1894, ccxxxii, 365) found evidence of the formation of tri-sodium pyrophosphate $Na_3HP_2O_7$ but no direct evidence of the existence of the monosodium salt.

Salzer allowed 10 grams of disodium pyrophosphate $Na_2H_2P_2O_7$ and 13.5 grams of tetra-sodium pyrophosphate, $Na_4P_2O_7$ to react in solution in 50 c.c. of water; evaporated on a water bath until a crust of crystals was formed, and only a little mother liquor remained, filtered boiling (otherwise mixed crystals are formed), and dried the salt as quickly as possible between filter paper. The tri-sodium pyrophosphate was obtained in small crystals soluble in about three times their weight of water, to form a solution neutral to litmus. The salt crystallised with one molecule of water, and remained unchanged on heating to 100°. On heating to 190° the salt lost one molecule of water. On further, and prolonged heating at 300°, another 3.4 per cent. of its weight was lost, corresponding with the formation of hexa-sodium pyrophosphate, but the existence of compounds of this type is not well established: $2Na_3HP_2O_7 = Na_6P_4O_{13} + H_2O$. Salts of this acid have been described by Fleitmann and Henneberg, who also described $Na_4H_2P_4O_{13}$, obtained by heating $Na_2H_2P_2O_7$ at 220° C. for one hour (*Ann.* 1848, LXV, 3244; see also Uelsmann, *Ann.*, 1861, CXVIII, 99). Salzer did not arrive at any definite conclusion as to the actual composition of this salt, but considered that it might be either (*a*) $Na_4P_2O_7 + 2NaPO_3$, or (*b*) $Na_3PO_4 + 3NaPO_3$. Schwarz (*Z. Anorg. Chem.* 1895, IX, 249) shewed that only $NaPO_3$ is formed in the reaction. Salzer also observed that a solution of tri-sodium pyrophosphate gave, with silver nitrate, a precipitate of normal silver pyrophosphate, and not $Ag_3HP_2O_7$.

H. Giran (*Compt. rend.*, 1902, cxxxiv, 1499) confirmed Salzer's results and also described a method for the preparation of mono-sodium pyrophosphate, $NaH_3P_2O_7$. He found that when one-fourth of an equivalent of caustic soda is added to a solution of pyrophosphoric acid, the solu-

tion evaporated, and alcohol added, di-sodium pyrophosphate is always precipitated, but if evaporation is carried out in the presence of excess of pyrophosphoric acid, a mixture of the mono- and di-sodium salts is obtained. Giran obtained the mono-sodium pyrophosphate by making an intimate mixture of anhydrous di-sodium pyrophosphate with six to eight times its weight of syrupy pyrophosphoric acid, heating at 100° for several hours, and spreading the paste in thin layers between two porous plates, the top one being weighted. When heated at 110-120° the porous plates absorbed the excess of acid; the semi-solid substance was removed, and the process repeated until the plates absorbed no more acid. Giran states that about five repetitions of this process are necessary is all.

Giran also measured the heats of solution of pyrophosphoric acid and its sodium salts, and from his measurements he deduced that the mono- and tri-sodium pyrophosphates were definite compounds. No mention of them will be found in the latest edition of Roscoe and Schorlemmer (Vol. 2, 1923), although a mere reference to Giran occurs in the earlier volume (Vol. 1, 1905, p. 668).

Experimental.

PREPARATION OF PYROPHOSPHORIC ACID.

Several methods were tried. Orthophosphoric acid was dehydrated by heating; hydrochloric acid gas was passed over heated neutral silver pyrophosphate, and sulphuretted hydrogen was passed through an aqueous suspension of lead pyrophosphate. There are serious objections, however, to all these methods.

The method actually used is due to Geuther (*J. prakt. chem.* (2) VIII, 359), and depends on the reaction between phosphoric acid and phosphoryl chloride:

$$5H_3PO_4 + POCl_3 = 3H_4P_2O_7 + 3HCl$$

The phosphoric acid used was prepared from red phosphorus and nitric acid. The solution was evaporated, very cautiously, in a platinum dish, to 180°, and was then placed in a vacuum desiccator, surrounded with a freezing mixture, and allowed to stand overnight. Phosphoric acid crystallised out in a very pure state. A slight excess of redistilled phosphoryl chloride was added, and this together with the the last traces of hydrochloric acid evolved in the reaction, were removed by the pnmp, and by warming. On cooling in a vacuum, the pyrophosphoric acid solidified and was found to be of a high degree of purity.

TETRA-SODIUM PYROPHOSPHATE.

Di-sodium orthophosphate was re-crystallised three times, and the salt heated to about 110 to expel water of crystallisation. The anhydrous salt was then heated to redness for an hour, the pyrophosphate recrystallised and heated again. The resulting tetra-sodium pyrophosphate, which was faintly alkaline to litmus, was found to be very pure.

DI-SODIUM PYROPHOSPHATE.

This was prepared by adding to a hot saturated solution of tetra-sodium pyrophosphate an equal bulk of glacial acetic acid, boiling for a few minutes, and precipitating the di-sodium pyrophosphate by alcohol. This salt was filtered at the pump, washed with alcohol, and dried in a vacuum. (Schwarzenberg. *Ann.*, 1848, LXV, 139). Analysis: 0.5262 gram gave 0.5238 gram $Mg_2P_2O_7$: theory for $Na_2H_2P_2O_7$ requires 0.5248 gram: percentage purity = 99.8.

ANALYSIS OF PYROPHOSPHATES.

The most successful method was found to be to boil a sample of the pyrophosphates with a large excess of dilute hydrochloric acid for about two hours, add magnesia mixture, boil for ten minutes and allow to stand. The magnesium ammonium phosphate is then filtered in a Gooch crucible at the pump, ignited, and weighed as pyrophosphate.

TRI-SODIUM PYROPHOSPHATE.

This salt was prepared according to the method given by Salzer, but the resnlts differed, in respect of the water of crystallisation, from those given by Salzer. The tri-sodium pyrophosphate obtained by rapid evaporation of the solution contained four molecules of water, but if the evaporation was carried out much more slowly a salt containing five molecules of water was sometimes obtained. The salts on heating at 100° lost, respectively, three and four molecules of water of crystallisation, leaving the monohydrate $Na_3HP_2O_7.H_2O$, which, as Salzer states, remains unchanged at that temperature. On further heating for an hour at 170-190° the anhydrous salt was obtained. Prolonged heating at 300° resulted in the hexa-sodium meta-pyrophosphate, $Na_6P_4O_{13}$, in accordance with Salzer's results.

Analyses of the tetra-hydrate:—

(*a*) 0.7388 gram gave 0.5122 gram $Mg_2P_2O_7$; (*b*) 0.4187 gram gave 0.2946 gram $Mg_2P_2O_7$. Percentage P_2O_5: (*a*)

35.50; (*b*) 35.42; average 35.46. $Na_3HP_2O_7.4H_2O$ requires 35.47.

Percentage loss of weight on heating:—
At 100°: (*a*) 17.09; (*b*) 17.25; average 17.17. Theory gives 17.09.

At 170-190°: (*a*) 22.74; (*b*) 22.35; average 22.55. Theory gives 22.77.

At 300°; (*a*) 24.57; (*b*) 25.58; average 24.93. Theory gives 25.63.

Analysis of the penta-hydrate:—
0.5866 gram gave 0.3919 gram $Mg_2P_2O_7$. Percentage P_2O_5: 33.62. Theory for $Na_3HP_2O_7.5H_2O$ = 33.56.

Loss of weight on heating:—
At 100°: (*a*) 21.73; theory 21.53. At 170-190°: 26.84; theory 26.92. At 300° 29.57; theory 29.67.

On heating the monohydrate, $Na_3HP_2O_7.H_2O$ at 170-190°, the loss in weight was 6.51 per cent., in accordance with Salzer's result. When crystals of the tri-sodium pyrophosphate were dissolved in water and re-crystallised, the salt deposited was of varying composition, and consisted apparently of mixed crystals of the di- and tetra-sodium pyrophosphates.

Attempts to analyse the hexa-sodium pyrophosphate by direct methods, by precipitating and collecting the lead, barium, and silver salts, gave varying results.

When hexa-sodium meta-pyrophosphate was dissolved in water the solution was colloidal, and this seemed to indicate, in accordance with Salzer's observation, that the salt is a true meta-phosphate. On evaporation of the aqueous solution no definite crystals were formed, but if the gelatinous substance was removed and dried, it was found, on analysis, not to correspond to $Na_6P_4O_{13}$, the phosphorus content being much lower than required by this formula. On heating the substance recovered by the evaporation of a solution of hexa-sodium meta-pyrophosphate, a loss of weigh was observed, owing to a loss of water, but this loss varied considerably (15-40 per cent.) and it was not decided whether the water was present as water of crystallisation or constitution.

If a solution of hexa-sodium meta-pyrophosphate was prepared in cold water, and silver nitrate solution added immediately, a white precipitate was obtained, but if the solution was boiled before the addition of the silver nitrate, the silver salt formed was distinctly yellow, but not of such a deep colour as silver ortho-phosphate. This seems to indicate the formation of pyro- and ortho-phosphates, as well as meta-phosphates in the solution.

MONO-SODIUM PYROPHOSPHATE.

This salt was prepared by the method given by Giran, but it proved very difficult to free the salt from the last traces of pyrophosphoric acid; analysis shewed that pyrophosphoric acid was always present in the final product to the extent of 0.2-0.3 per cent. The mono-sodium pyrophosphate so prepared was a brittle substance, easily powdered, and very deliquescent. A solution of the salt in water is distinctly acid to litmus.

(*a*) 0.6990 gram gave 0.7806 gram $Mg_2P_2O_7$; (*b*) 0.5886 gram gave 0.6578 gram $Mg_2P_2O_7$. Percentage P_2O_5: (*a*) 56.21; (*b*) 56.24; average 56.23. Theory for $NaH_3P_2O_7$ = 56.05.

Solutions of mono-sodium pyrophosphate could not be recrystallised, but from a concentrated solution alcohol precipitated a salt, which on analysis was found to be almost pure di-sodium pyrophosphate.

SUMMARY.

The work of Giran on the preparation of tri-sodium hydrogen pyrophosphate and tri-hydrogen sodium pyrophosphate has been repeated, and although the results sometimes differed in detail from his, the existence of the salts $Na_3HP_2O_7$, $Na_3HP_2O_7.4H_2O$, $NaH_3P_2O_7$, and a new salt $Na_3HP_2O_7.5H_2O$, has been confirmed. The salt formed on strongly heating $Na_3HP_2O_7$ has the composition $Na_6P_4O_{13}$. It was considered by Giran to be a dipyrophosphate, but its properties point rather to its being a polymerised meta-phosphate.

We have not yet been able to extend our experiments to the solutions of the two salts described, $Na_3HP_2O_7$ and $NaH_3P_2O_7$. It was originally intended to repeat the thermochemical experiments of Giran and to add to them a study of the conductivities of the solutions. It must be kept in mind, however, that there is no reason why there should be any evidence of the existence of these salts in solution because they can be prepared in the solid state. There are many salts which exist in the solid state but not in solution; bleaching powder is perhaps the commonest example. No useful information as to the existenee of such salts can be obtained by a study of their solutions any more than evidence of the existence of phosphorus pentachloride could be obtained by such methods. On the other hand there are salts which, apparently, can exist only in solution, and in this case also no reason for denying the existence of the salt need arise from a failure to prepare it in the solid state. Until fairly recently objection could

have been taken to the existence of cuprous sulphate, since attempts to prepare it from its very unstable solutions were without result. The question of the existence or otherwise of salts is not one which can be decided by any test-method, and although in many cases it is possible to prepare phase-rule diagrams of system showing the existence of solid salts it may usefully be kept in mind that this method is not universal, and that there will be many cases to which it will not apply. The actual isolation of a solid salt may be possible only by the use of very special methods, and in the preparation of the thiopyrophosphates, which will be considered in another communication, we may see a good example of this. We think it necessary to add these elementary remarks since there appears to exist in certain quarters a belief that unless the preparation of a salt is accompanied by phase-rule diagrams there is some doubt of its existence. This method, however, is well known to be subject to serious limitations and in some cases it can only be misleading.

East London College.
University of London.

THE LEAD-TIN SYSTEM OF ALLOYS RE-EXAMINED BY AN ELECTRICAL RESISTANCE METHOD.

By F. H. Jeffery.

(*Faraday Society, January 2, 1928.*)

This system was investigated by Rosenhain and Tucker by means of micrographic and thermal analysis; they did not find the upper boundary of the solid solution of tin in lead nor the tin end of the line of eutectic points, they found a line of points at 149° C. from 18 per cent. tin in lead to 62.9 per cent. but were unable to find its continuation for alloys richer in tin. Paravano and Scortecci examined the lower boundary of the solid solution of tin in lead by measuring the electrical resistances of rods of the alloys. They did not find a line of points at 149°. Konno also used an electrical resistance method, his method being to express the specific resistance of an alloy as a function of the temperature—the alloy was enclosed in silica tubes dipping into a larger mass of alloy contained in a crucible. His diagram did not give any indication of solid solutions of lead in tin.

Apparatus and Procedure.

A continuous method of recording change of electrical resistance as a function of the temperature by means of two Callendar recorders was used; it has been described in a previous paper. The alloys were made from Johnson and Matthey's best tin and assay lead foil, the mass of each being about 400 grams. Both heating curves and coolingcurves were made for finding the boundaries of the solid solutions and to investigate the existence of a line of points at 149° for alloys in true equilibrium. The rates of heating and cooling were so adjusted that in nearly all cases they gave identical results. Special precautions had to be taken for alloys of composition 20 per cent. to 66 per cent. tin in lead; when cooling from liquidus to a little above the eutectic temperature the average time taken was seventy hours, and when the alloys had reached 170° C. after passing through the eutectic temperature they were held at this for about forty hours. The average rate of cooling and heating through the boundaries of the solid solutions and through the 149° line was 0.2° C. per min., but often 0.1° C. per min. was used. The rate of cooling through the liquidus was 0.2° per min.

Discussion of Results.

The equilibrium diagram is of the Roozeboom type 5. The *line of eutectic points* is at 183° C., the phases at the eutectic point being of compositions 16.5 of tin and 97 per cent. tin. The composition of *the eutectic alloy* is 66.0 per cent. tin; Rosenhain and Tucker gave 62.9 per cent. tin. An alloy of this composition was found to have a well-defined point on the liquidus at 190° both for cooling and heating curves—the latter were made at the rate of 0.1° C. per min. *The line of points at* 149° C. does not appear to exist when precautions are taken to avoid metastable conditions. These arise at temperatures between those of the liquidus and the eutectic for alloys of compositions 20 per cent. to 66 per cent. tin. Alloys of composition 20 per cent. tin, 30 per cent., 50 per cent., and 60 per cent. were cooled to 170° C. without the precaution of the very slow cooling between the liquidus and temperatures just above 183° C., they were then held at 170° for about twenty to forty hours and then cooled at 0.2° C. per min.; there were arrests at 151° C., 149° C., 151° C., and 146° C. respectively. No similar metastable conditions occurred for alloys containing more than 66 per cent. tin, no conditions were obtained at which points on the 149° C. line were ever found. Further evidence of the absence of this line is afforded by the absence of a break on the lower boundary

of the solid solution of tin in lead. Parravano and Scortecci used this argument also, but when the author plotted their points on the same scale as that of his own diagram he founr them to give two straight lines intersecting at an angle of 21° at 150° C., also all the points were lower than his.

According to the diagram of Rosenhain and Tucker an alloy of 13 per cent. tin would be homogeneous at 150° C. An ingot was cast on glass, annealed for nine days at 150° C., chilled and polished with benzene and chromic oxide and etched with potassium syanide. It was a two-phase system with bright patches of the tin rich solid solution. This is consistent with the author's diagram.

The electrical resistance methods of Parravano and Scortecci and of Konno appear to the author to involve the same possibilities of error when applied to the lead-tin systems when rods of the alloys are used as were stated by him for the case of the copper-tin system.

SUMMARY.

1. A continous method of recording change of electrical resistance as a function of the temperature by means of two Callendar recorders has been applied to the lead-tin system.

2. With precautions adequate to ensure equilibrium the diagram has been found to be of the Roozeboom type 5, without any complication, for temperatures down to 75° C.

3. The boundaries of the solid solutions of tin in lead and of lead in tin have been found.

4. No line of points has been found at 149° C.

EARLY CHEMISTRY IN IRELAND.

On November 8, at Trinity College, Dublin, before the Dublin University Experimental Science Association, Dr. James Bell read an address on "The History of chemistry in Ireland."

The following abstract of the address will be read with interest, especially by Celtic readers, on both sides of the Irish sea.

For 2,000 years chemistry was dominated by the belief in alchemy, that is the possibility of transmuting baser metals, such as lead and mercury, into gold. So much did this idea obsess the minds of alchemists that little else was done. No doubt exists that the ancient Irish had some knowledge of alchemy.

Towards the end of the sixteenth century, Edward Kelly, having forged several public documents in Ireland, fled the country. He is next heard of in the position of alchemist to Rudolf II. at Prague. Here, it is said, he converted mercury into gold, obtaining a knighthood. The Emperor, to find out the secret, cast Kelly into prison. In attempting to escape he broke his leg, with fatal results.

Modern chemistry commences with Robert Boyle, who denounced the alchemists and gave chemistry its present scientific basis. He is spoken of as the "Father of Modern Chemistry." He was the son of the Earl of Cork, but did not work in Ireland. Boyle was not wholly lost to Ireland. His influence fell on two Dublin men, the brothers Molyneaux, graduates of Trinity College, who started chemistry in Dublin. William Molyneaux in 1683 founded the Dublin Philosophical Society, which was short-lived owing to civil war. Its work was taken up by the foundation in 1731 of the Royal Dublin Society, and in 1756 by the forerunner of the Royal Irish Academy.

Richard Kirwan, born in Galway in 1733, studied chemistry in London for ten years. On his return with new ideas, chemistry received a great spurt in Dublin. A contemporary of his, William Higgins, a Sligo man, educated in England, was made chemist to the Apothecaries' Company of Ireland at the then princely salary of £200 a year, with apartments, coals and candles. In 1795 he was made Professor of Chemistry to the Royal Dublin Society. Higgins had some idea of an atomic theory twenty years before Dalton, but unfortunately failed to follow up his idea.

During this time the University played no significant part in chemistry, owing mainly to a distrust of the science on the part of the authorities. A succession of lecturers, of whom little is known, was attached to the Medical School from its foundation in 1771. The present chair was founded in 1785, its first occupant being Dr. Uerceval, of whom it is recorded that he knew little chemistry. He was followed in 1809 by Francis Barker, of whom little is recorded. He held the chair till 1850, being followed by Apjohn, whose claim to fame rests more on physics than chemistr; he was, however, in instrumental in bringing out the first edition of the *British Pharmacopœia.*

The appointment of Barker coincided with a great advance in chemistry. The famous Sir Humphry Davy was brought to Dublin by the Royal Dublin Society, before which he delivered a series of six lectures on the application of chemistry to agriculture, receiving a sum of £750. He also obtained an honorary degree from the University.

His visit led to the appointment, in 1826, of his brother Edmund to succeed Higgins as chemist to the Royal Dublin Society. Here, in 1836, he made one of the greatest chemical discoveries ever made in Dublin, namely acetylene gas. About the same time Sir Robert Kane, born in Dublin and educated in Trinity College, made an important discovery in connection with theoretical chemistry, obtaining a cyclic hydrocarbon from an open-chain compound.

Professor Apjohn retired in 1875, when James Emerson Reynolds wa called upon to take the Chair. Although intended for the medical profession, he taught himself chemistry with great success; perhaps no one has done more to further the reputation of Dublin chemistry than he. Reynold's best known contribution to chemistry was the discovery of thiourea, an exceedingly reactive compound, which led up to Dr. Werner's great work on the chemistry of urea itself.

THE CHEMICAL ENGINEER.

His Status and Importance.

By Professor E. C. Williams.
University College, London.

The rapid growth of chemical industry in all civilized countries has called into being a new type of industrial scientiest who is skilled in the translation of the results of the laboratory into technically and commercially efficient manufacturing operations.

The modern need for co-operation between the chemist and the industrialist has compelled the evolution of a man , trained in the sciences of chemistry, physics, and engineering, whose function is to plan the industrial operation of chemical and allied processes, which involves the building up, first of a rational process, and then of a plant for carrying it out, which shall be economically, chemically, and mechanically as perfect of its kind as possible.

It is possible to train a man to a sound knowledge of the methods of synthetic and physical chemistry and at the same time an appreciation of what is possible to the electrical engineer. Such a man working in close co-operation with a mechanical engineer can design and erect the plant for the operation of any chemical process. This combination of chemical and engineering sense is the characteristic of the chemical engineer.

The chemical engineer need not be equally a brilliant research chemist and a sound mechanical engineer; he will have at his elbow representatives of both these professions. He is rather the *tactician* of chemical industry, who works out in detail the methods by which the technical forces are to achieve the end in view. If in addition he has that wide economic vision which appreciates the resouces and future needs of the world, he becomes the *strategist* of the industry, the directive force, not only in chemical, but in world affairs. The vision he needs exceeds that required in almost any other industry, since chemical industry is peculiar in that it must plan not for months but for years ahead. The industry needs far-sighted technical and no less far-sighted financial policy. Such vision is commonly believed to be the prerogative of the financial leaders, but with industry based on the combined power of chemistry and engineering, financial or commercial vision alone will not suffice.—*Times, Trade and Engineering Supplement.*

RESEARCHES ON SULPHONATED OILS. I. ON RICINOLEIC ACID SULPHURIC ESTER.

By Kinziro Winokuti.

In undertaking the investigation of sulfonated oil, the author has established his object in view, in pure preparation of each constituent of the sulfonated oil and in examining their properties connecting with the characteristics of the practical goods, and then considering about the relation between the properties of these individuals and ones as a whole, further, in considering by what conditions should the quality of the product be influenced.

The author dealt first, with ricinoleic acid and its sulfuric ester which are closely connected with the sulfonated castor oil. To prepare the sulfuric ester the author traced first the Grün and Woldenberg's process (Inaug. Dissert., Zürich, 1908; *J. Amer. Chem. Soc.*, 1909, 490), and was not satisfied with it. He attained, however, his object by the following process :

The crude ester obtained by the Grün-Woldenberg's process was neutralised with

NaOH in alcoholic solution instead of ammonia, and cooling the resulting solution, a crystalline deposit was obtained. From this deposit, after repeated recrystallisation from ethyl alcohol, the colorless needle crystalline Na-salt of the ester was isolated in such a purity that can never be attained by Grün's Ba-salt which was precipitated from ammonium salt solution. The author examined its general properties, and found that its formula is $[CH_3.(CH_2)_5.CH.O.SO_3Na.CH_2.CH.(CH_2)_7.CO_2Na].H_2O$ when crystallised from 95 per cent. alcohol, and that it has many superior and favourable properties not only as an important component in the sulfonated oil but also as a convenient material for the investigation of the sulfonated oil.—*Society of Chemical Industry, Japan.*

GENERAL NOTES.

PULVERISED FUEL PROGRESS.

The year 1927 may be regarded as the year in which pulverised fuel firing established its right to a leading position in combustion processes. Power-station engineers, hitherto dubious as to the greater advantages offered by the use of pulverised fuel, have practically, throughout the whole country, recognised the accuracy of the assertions of American engineers as to the value of the system. In America the total heating surface in this form of firing amounts now to nearly 7,000,000 square feet. In the year 1924 the total heating surface amounted to 2,100,000 square feet. In Great Britain and Ireland the total heating surface under pulverised fuel now amounts to 862,626 square feet. a figures which has been attained within two years.

Other countries have also substantially recogniesed the superiority of this form of firing, where large demands for power are required to be met. The large new stations at Congella, South Africa, at Buenos Ayres, and at Shanghai are all being equipped with pulverised fuel plant, while Germany has long recognised the advantages associated with this description of firing for large boiler plants as well as for metallurgical furnaces.

It may be noted that the power stations and industrial plants in Great Britain operating on the "Lopulco" system include the largest and most recent additions to our power-plants.

Advantages of Pulverised Fuel.

Among the principal reasons which account for the rapid increase in the use of pulverised fuel are improved thermal efficiency, greater operating convenience, reliability and a wider choice of fuels. What really interests the power-station engineer is the average efficiency taken over prolonged periods under ordinary station operating conditions, and in this connection there is no doubt whatsoever that the pulverised coal-fired boiler scores. With this system of firing, also, almost any grade of fuel may be efficiently consumed. The fuels that have been successfully consumed in powdered form include the whole range of bituminous and semi-bituminous coals, anthracite coals, lignite, brown coal and even pitch. With this system the lowest grades of coal produced, and fuels which have hitherto been regarded as useless, are made available for power production. Such low-grade fuels cannot be employed in ordinary practice under the fluctuating load conditions encountered in an electric generating station, without considerable sacrifice of efficiency and reduction in the steaming capacity of the boilers.

The fuel may be purchased almost solely on a basis of cost per unit of heat without regard to its physical condition, and this constitutes a great economic advantage to the majority of plants.

PORTLAND CEMENT SELLING AND DISTRIBUTING COMPANY, LTD., DIARY.

We have received from the Portland Cement Selling and Distributing Co., Ltd., 27, Buckingham Gate, London, S.W.1., a copy of their Red Triangle Diary for 1928. From the data contained therein it has evidently been designed specially for Architects, Surveyors, Structural Engineers, Borough Engineers, Builders and Contracors, to whom it will be of inestimable value. It is published from 27, Buckingham Gate, London, S.W.1., and we are informed by the Editor that he will gladly send a copy to any *Chemical News* reader applying for one, who is engaged in any of the above trades.

DR. JAMES F. NORRIS BECOMES CONSULTING EDITOR OF THE INTERNATIONAL CHEMICAL SERIES.

Dr. James F. Norris, of the Massachusetts Institute of Technology, who holds the title of Director of the Research Laboratory of Organic Chemistry, In Charge, Graduate Students in Chemistry, has assumed the Consulting Editorship of the International Chemical Series. This series, which now comprises upwards of thirty titles, was first undertaken in 1910, by the McGraw-Hill Book Company, under the Consulting Editorship of the late Dr. H. P. Talbot of the Massachusetts Institute of Technology.

The first books published in this series were Dr. Norris' "Principles of Organic Chemistry," and Dr. H. P. Cady's "Inorganic Chemistry," which came out on October 17, 1912.

There is something peculiarly fitting in Dr. Norris' succession to Dr. Talbot. He has been associated with Dr. Talbot for considerable periods since 1895, when he joined the Department of Chemistry at the Massachusetts Institute of Technology immediately after receiving his degrees at Johns Hopkins University. From 1904 to 1915, he was Professor of Chemistry at Simmons College, Boston. He then spent a year as Professor of Chemistry at Vanderbilt University, returning to the Massachusetts Institute of Technology in 1916.

Dr. Norris was President of the American Chemical Society in 1925 and 1926. He made a notable record in the Chemical Warfare Service during the World War and since the war, in many important industrial researches. He brings to the International Chemical Series a rare combination of experience and ability.

BRITAIN BEHIND AMERICA.

Mr. George E. Learnard, one of America's leading engineers, who has rendered great service to all manufacturing countries by his practical work in cheap power production, recently paid a flying visit to this country.

In an interview given to the Bureau of Fuel Economy, Mr. Learnard indicated the great progress America was making in reducing the cost of production by employing higher boiler pressures in boiler plants. This movement, he said, had been com- A e...d in Great Britain, and it was bound of electr...ue. By the use of pulverised coal Lopulco" system, Mr. J. Anderson, of Milwaukee, had been enabled to produce one kilowatt of electrical energy from 1 lb. of coal. This achievement will be of interest to the Central Electricity Committee, who have in hand the reorganisation of electricity supplies. Mr. Learnard also pointed out that Germany was also making rapid progress in adopting the most economic methods of electricity production.

Mr. Learnard believed that the slow progress being made in this country in cheap steam production was due mainly to the fact that the manufacture of boiler plant in this country was limited to practically a speciality on the part of a few firms who saw no commercial reason to alter their plant to meet changing conditions. This situation was, however, now he believed, about to be overcome, due to numerous changes in design, particularly through the adoption of the solid-forged and water-welded, rivetless drums used for the higher pressures now being specified, and also to the fact that the vertical tube type boiler was rapidly displacing the old horizontal tube-type boiler, on account of its many advantages in both design and operation.

Low Temperature Carbonisation.

Referring to Low Temperature Carbonisation, Mr. Learnard asserted his complete conviction of the ultimate success of this application and stated that a Milwaukee, a very large plant had already been laid down at the power station, the gas from the process being delivered and used by the local gas undertaking whilst the whole of the residual fuel, or pulverised semi-coke was transported by pumps direct from the carbonising retorts to the furnaces in the boiler house and is being regularly and most successfully burnt without further treatment. In America, every well-informed engineer, said Mr. Learnard, is closely following this further progressive development and during 1927 one of the most important contracts received by this International group covered the supply of a 750 ton plant for the production of gas by the low temperature system for he New Jersey Gas Undertaking.

THE REID PROCESS.

The process of the late Dr. T. A. Reid, Ph.D., F.C.S., of creating power-gas from the gases given off during lime burning is we understand suffering damage through confusion with certain lime fuel schemes that were recently before the public. Mrs.

Ethel Reid, widow and executrix of the late Dr. Reid, and now owner of the process, feels agrieved at this state of things. We are informed that the Reid power-gas process bears no relation whatever to any chalk fuel or other processes. It is a simple patent for converting into a power-gas gases given off when lime and coal are burning together —as they must do in the ordinary process of lime-burning—and no claims which cannot be substantiated by practical demonstration will be made for this power-gas. The plant for doing this will, we learn, soon be ready and, until that time, readers are asked to suspend judgment as to the value or otherwise of the patent.

BITUMINOUS COAL.

Dr. Thomas S. Baker, president of the Carnegie Institute of Technology in Pittsburg, Pennsylvania, U.S.A., who organised the International Conference on Bituminous Coal held at his institution in 1926, sailed on the "Berengaria" for Europe on February 10, according to an announcement. He will spend about six weeks in several European countries for the purpose of organising the foreign part of the second International Conference on Bituminous Coal which will be held at the Carnegie Institute of Technology in the week of November 19, 1928.

While in Paris, Dr. Baker will give a series of four or five lectures in French between March 15 and 22 under the auspices of the Carnegie Endowment for International Peace. His general subject will be "What the United States is Thinking About."

SAFETY IN MINES RESEARCH BOARD REPORTS.

Three Reports have already been issued by the Safety in Mines Research Board (S.M.R.B. Papers Nos. 5, 21 and 35), describing research on devices which will afford release of pressure of a firedamp explosion within the casing of an electric apparatus, yet will not allow the passing of flame to the outside atmosphere.

Apart from the pressure produced by the explosion of any firedamp-air mixture that may exist within the casing, it appeared possible that high pressures might arise due to *arcing during switching operations* or through the blowing of fusible cut-outs. An account of research regarding the probabl magnitude of such pressure, and the conditions of its production, forms the subject of two papers by G. Allsop and R. V. Wheeler, entitled "The Pressures produced on Blowing Electric Arcs in Closed Vessels" (safety in Mines Research Board Papers Nos. 38 and 39, H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2., price, respectively, 1s. 6d. and 9d. net. These papers give in detail an account of the two investigations, the methods of research, the apparatus employed, and the results of the experiments.

SLAG, COKE BREEZE AND CLINKER.

Breeze and clinker are used extensively as concrete aggregates, but at present there is very little information available regarding the fundamental causes of the failures which are of too frequent occurrence. Such information as is contained in the literature on the properties of these aggregates and the methods of determining their suitability for building purposes is summarised, however, in a Report recently issued by the Department of Scientific and Industrial Research.

Preliminary investigations at the Building Research Station, indicate that, in general, the important factor determining the soundness of these materials is the completeness of the combustion of the coal in the furnace. It is hoped that the further experimental work will provide definite information on the properties of clinker and make it possible to evolve reliable tests for its suitability as a concrete aggregate.

CANADIAN TRADE IN 1927.

According to figures just issued by the Dominion Bureau of Statistics at Ottawa, the total external trade of Canada during the year 1927 was as follows:—

Imports, 1,087,117,930 dollars; exports of Canadian products, 1,218,336,773 dols., and exports of foreign goods, 20,445,231 dols. The corresponding figures for 1926 were 1,008,341,911 dols., 1,268,581,976 dols., and 15,357,292 dols.

HYDRO-ELECTRIC PROGRESS IN CANADA DURING 1927.

The Dominion Water Power and Reclamation Service of the Department of the Interior of Canada has prepared a bulletin

giving a review of hydro-electric and water-power development in Canada during 1927, which shows that the activity in hydro-electric and water-power development which has been manifest during the past few years throughout the Dominion continued without abatement during 1927, and sufficient undertakings are either under construction or in early prospect to ensure substantial progress being maintained in 1928 and the years immediately following.

In 1927 hydro-electric power equipment was installed ready for operation to the extent of 221,655 horse-power, while other undertakings were advanced to such a stage that a further total of 378,000 horse-power will be in place during the first six or seven months of 1928. With the additions during the year the total installation in Canada has grown to a figure of 4,777,921 horse-power at the end of 1927 which will shortly be raised to more than 5,100,000 by the installations now in process of completion.

BOARD OF TRADE ANNOUNCEMENT.

Safeguarding of Key Industries.

The Board of Trade give notice that representations have been made to them under Section 10(5) of the Finance Act, 1926, regarding methyl chloride and radium compounds.

Section 10(5) of the Finance Act, 1926, is as follows :—

" The Treasury may by order exempt from the duty imposed by section one of the Safeguarding of Industries Act, 1921, as amended by this Act, for such period as may be specified in the order, and article in respect of which the Board of Trade are satisfied on a representation made by a consumer of that article that the article is not made in any par of His Majesty's Dominions in quantities which are substantial having regard to the consumption of that article for the time being in the United Kingdom, and that there is no reasonable probability that the article will within a reasonable period be made in His Majesty's Dominions in such substantial quantities."

Any person desiring to communicate with the Board of Trade with respect to these representations should do so by letter addressed to the Principal Assistant Secretary, Industries and Manufactures Department, Board of Trade, Great George Street, S.W.1., within one month from the date of this notice.

FEDERATION OF BRITISH INDUSTRIES.

The following resolution has been passed :

" That the Council appoints a committee to consider what amendments to the Railway Companies' Transport Bills are necessary to safeguard the public interests and users of transport, and empowers this committee to negotiate with the Railway Companies wih a view to the inclusion of such amendments in the Bills and failing success in such negotiation, to approach the Government with a request for a full enquiry before the Bills receive a second reading. Meanwhile, in order to retain the Federation's freedom of action, any necessary formal steps should be taken to maintain the Federation's status to deal with the matter in Parliament, should this prove necessary."

Proceedings and Notices of Societies.

INSTITUTE OF METALS.

Papers to be Read in March, 1928.

A. I. Norbury : " The Effect of Quenching and Tempering on the Mechanical Properties of Standard Silver."

R. Chadwick, B.A., A.I.C. : " The Constitution of the Alloys of Magnesium and Zinc."

Hugh O'Neill, M.Met., M.Sc. : " Historical Note on Density Changes caused by Cold-working of Metals."

William A. Cowan, B.A. : " Minute Shrinkage Cavities in Some Cast Alloys of Heterogeneous Structure."

William A. Cowan, B.A. : " Note on the Composition of Old Roman Lead."

J. Newton Friend, D.Sc., Ph.D., F.I.C., and W. E. Thorneycroft, B.Sc. : " An Example of Roman Copper ' Soldering ' and Welding from Uriconium."

Major F. S. Grimston, C.I.E. : " Season-Cracking of Small Arms Cartridge Cases During Manufacture."

G. L. Bailey, M.Sc., A.I.C. : " The Influence of Dissolved Gases on the Soundness of 70 : 30 Brass Ingots."

J. Newton Friend, D.Sc., Ph.D., F.I.C. : " The Relative Corrodibilities of Ferrous

and Non-Ferrous Metals and Alloys. Part I. —The Results of Four Years' Exposure in the Bristol Channel."

Ezer Griffiths, D.Sc., F.R.S., and F. H. Schofield, B.A., B.Sc.: "The Thermal and Electrical Conductivity of Some Aluminium Alloys and Bronzes."

T. E. Allibone, M.Sc., Ph.D., and C. Sykes, M.Sc.: "The Alloys of Zirconium."

S. Beckinsale, B.Sc., A.I.C., and H. Waterhouse, M.Met.: "The Deterioration of Lead Cable Sheathing by Cracking, and its Prevention."

Max Haas, Dr.Ing.: "The Dilatometric Study of Light Metals."

F. Hargreaves, A.R.S.M.: "The Ball Hardness and the Cold-Working of Soft Metals and Eutectics."

W. L. Kent, B.Sc.: "The Behaviour of Metals and Alloys during Hot-Forging."

Tsotomu Matsuda, Sc.D.: "On the Quenching and Tempering of Brass, Bronze and Aluminium-Bronze."

SOCIETY OF PUBLIC ANALYSTS.

An Ordinary Meeting of the Society was held at the Chemical Society's Rooms, Burlington House, on Wednesday, February 1, the President, Mr. E. Richards Bolton, being in the chair.

Certificates were read for the first time in favour of John Edmund Aps, Edward Eric Billington, M.Sc., Ralph C. Chirnside, Ralph David Owen, A.I.C., A.M.I.Chem.E.

Certificates were read for the second time in favour of :—Andrew R. Buchanan and Arthur Gordon Francis, B.Sc., F.I.C.

The following were elected Members of the Society :— George Reginald Barnes, B.Sc.; Cecil Abell Bassett, B.Sc., A.I.C.; Ethel Irene Beeching, M.Sc., A.I.C.; Harold Pease Buttrick, A.I.C.; Cecil Owen Harvey, B.Sc., A.R.C.S., A.I.C.; Harold Vivian Horton, B.Sc., A.I.C.; Thomas Howard, M.Sc., A.I.C.; Harold McKee Langton, M.A., B.Sc., A.I.C.; William Alfred Nottage Markwell; Walter George Messenger, B.Sc., A.I.C.; Edward John Newby, B.Sc.; Horace Samuel Rooke, M.Sc., A.I.C.; S. Sera, Claude Trevine Symons, B.A., F.I.C.; David Rees Thomas, M.B., Ch.B.; and Wilfred A. Whitley.

The following papers were read and discussed :—

The Determination of Butter in Margarine. By L. V. Cocks, A.I.C., and E. Nightingale.

A critical survey of the Reichert-Meissl, Polenske and Kirschner processes has shown that small amounts of sulphuric acid may be volatilised and included in the acids recorded in the Kirschner value, unless special precautions are taken to prevent this. When the Kirschner value of the butter in a mixture is known, accurate percentage results are obtainable but, when that value (which may vary from 19 to 27) is not known, it is not permissible to state the actual percentage of butter with greater accuracy than between the limits of minus 13 per cent. and plus 24 per cent., both figures being calculated on the reading that would be obtained from the standard graphs for a butter fat with a Kirschner value of 23.5.

A New Method for the Separation and Determination of Small Amounts of Lead. By B. S. Evans, Ph.D., F.I.C.

The method is based on the quantitative deposition of the lead on copper from a cyanide solution containing ammonium oxalate. As in the presence of some metals the deposit is not very adherent, a percolation apparatus containing copper filings is used. By working in the cold the interference of tin, antimony, zinc, cadmium, and nickel is eliminated; bismuth is deosited, but, in the amounts present in commercial coppers, does not interfere. The depositel lead is converted into sulphate and then into chromate, which is dissolved in nitric acid, and the chromate ion is determined colorimetrically by comparison with standard (N/100) potassium dichromate solution containing nitric acid.

Investigations into the Analytical Chemistry of Tantalum, Niobium and their Mineral Associates. By W. R. Schoeller, Ph.D., and A. R. Powell. *X. The Separation of Silica from the Earth Acids.*

The disputed volatilisation of the fluorides of tantalum and niobium is discussed. Evaporation of the mixed oxides with hydrofluoric and sulphuric acids is not accurate with small amonnts of silica. Accurate results are obtained by fusing the mixed oxides with bisulphate, extraction of the fused mass with oxalic or tartaric acid, and treatment of the impure silica residue with hydrofluoric acid.

XI. The Precipitation of Titanium by Tannin.

Tannin produces a red precipitate in oxalic or tartaric solutions of titanium; the precipitation is quantitative in the neutral ised solution. Titania interferes with the tannin precipitation of tantalum from niobium, if present in quantities greater than about one hundredth of the tantalum oxide, by causing a discolouration of the yellow tantalum precipitate.

The Determination of Carvone in Dill Oil. By R. REILLY, D.Sc., F.I.C., AND P. J DRUMM.

Carvone is precipitated in the cold from an alcoholic solution of dill oil by means of semicarbazide hydrochloride and sodium acetate, and the resulting semicarbazone collected, dried *in vacuo* over sulphuric acid and weighed. The carvone semi-carbazone thus obtained melts at 141-142° C., whilst its isomer (m.pt. 163° C.) is formed if the temperature of the reaction mixture is allowed to rise.

Seasonal Variations in the Composition of the Latex of Hevea Brasilensis. By NORMAN RAE, M.A., F.I.C.

Monthly analyses of the latex of *Hevea Brasiliensis* have been made throughout a year. Nitrogen, potash and phosphoric acid rise to a maximum in February, fall until May, increase somewhat till July, and then fall to August. Leaf fall and renewal of leaves coincide with the fall in March, and maturing of seeds with that in July. It is suggested that the latex is a food reserve to be used up when leaf growth and seed growth are most actively proceeding.

THE OPTICAL SOCIETY.

At the meeting held at the Imperial College of Science, Imperial Institute Road, South Kensington, at 7.30 p.m., on Thursday, February 16, the following papers were read :—

An Investigation into the Beam from a Standard Lighthouse Lens." By W. M. HAMPTON, Ph.D., B.Sc., F.Inst.P., A.I.C.

The "Absolute" Hartmann Test. By R. KINGSLAKE, M.Sc., A.R.C.S., D.I.C., F.R.A.S.

The following demonstrations were given :—

A Portable Stereoscopic Kaleidoscope. By DR. REG. S. CLAY AND SIR RICHARD PAGET.

The Clarke Optical Smoke Box. By MESSRS. G. CUSSONS, LTD.

VICKERS-ARMSTRONGS LIMITED.

Vickers-Armstrongs Limited inform us that they have received an order for four "O" Class Submarines for the British Admiralty.

NOTICES OF BOOKS.

Inorganic Chemistry, Mainly Metals. By G. H. BAILEY, D.Sc. (Lond)., Ph.D. (Heidelberg), AND D. R. SNELLGROVE. Ph.D., M.Sc. (Lond.), F.C.S., A.I.C. Pp. VIII + 430. Price 6s. 6d. London: University Tutorial Press, Ltd., High Street, New Oxford Street, W.C.

This compact work has been written mainly to meet the requirements of students preparing for an Intermediate University Examination, and it is certain to fulfil the expectations of the experienced authors. The success that has been gained by Dr. Bailey's popular work, "The Tutorial Chemistry," will, we predict, be achieved by the present work. The book is divided into two sections (1) General and Physical Chemistry; and (2) The Metals. There are several illustrations, and each chapter is followed by a series of questions, which will aid the student in gaining the required knowledge of the subject, and prove also an advantage to the teacher.

Quarterly Magazine.

The Australasian Institute of Mining and Metallurgy, whose head offices are at 374, Little Collins Street, Melbourne, issues a quarterly magazine, in which are recorded the many useful activities carried out under its auspices. No. 64, dated December 31, 1926, contains an exhaustive and interesting paper by Mr. M. L. Stillwell, on "Mineral Constitution of Broken Hill Lode," with numerous illustrations. No. 65, dated March, 1927, contains papers "On Boiler Work Treatment," by Victor T. Edquist; "On Geophysical Prospecting," by H. W. Gepp, J. F. Hughes, and H. S.

Elland; and "On Chinese Non-Ferrous Metals," by Robert Slessor. No. 66, dated 30 June, 1927, contains a synopsis of the "Geology of the Lyell District, Tasmania," by Loftus Hills, D.Sc., and a very interesting account by the President of his visit to the U.S.A. and Canada.

International Yearbook of Agricultural Legislation.

The International Institute of Agriculture at Rome has recently published the *International Yearbook of Agricultural Legislation* dealing with the laws relating to Agriculture passed during 1926 throughout the world. The volume, which consists of 800 pages, contains a complete series of laws, decrees and regulations on Agriculture, published in 133 different countries during 1926, the full text or the title only being given according to the importance of the subject. The laws thus treated in the present annual refer to the following subject: Trade in agricultural products; agricultural machinery, fertilisers and live stock; laws dealing with finance and customs regulations; plant and animal production and the related industries; agricultural organisation and instruction; plant diseases; co-operation, insurance, agricultural credit; land tenure; relations between capital and labour in agriculture.

Owing to the importance of the questions treated and the comprehensive character of the documentary material contained, this Yearbook is indispensable to legislators, legal authorities, sociologists, economists, agricultural associations—in a word, to all who are interested either in agriculture itself or in the trade in the products of the land and their industrial exploitation.

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ROYAL INSTITUTION.

On Tuesday next, February 21, at 5.15 p.m., Prof. J. S. Huxley begins a course of six lectures at the Royal Institution on "The Behaviour of Animals"; on Thursday, February 23, Prof. F. Ll. Griffith will give the first of two lectures on "Nubia in Antiquity and in the Middle Ages"; and on Saturday, February 25, at 3 p.m., Mr. Campbell Dodgson will commence a course of two lectures on "The Life and Work of Albrecht Dürer." The Friday evening Discourse on February 24 will be delivered by Prof. George Gordon on "The Lives of Authors"; and on March 2 by Sir Farquhar Buzzard on "The Psychology of the Sick."

CORRESPONDENCE.

WHY WAIT FOR NEW SMOKE LAWS?

(*To the Editor of the* CHEMICAL NEWS.)

Sir,—It is futile to legislate in advance of public opinion, and I think that much of the criticism of the failure of the Government to include domestic smoke in the recent Smoke Abatement Act is ill-timed. Much remains to be done to educate the public regarding the evils of domestic smoke and the intelligent use of alternative fuels to raw coal, before we can successfully legislate against the domestic chimney.

It is surprising to find that even in usually well-informed quarters so little is known of the *immediate* possibilities of low temperature carbonisation as a factor in the campaign against atmospheric pollution. The success already achieved in Yorkshire in the commercial production of smokeless fuel from coal, after winning from it those valuable tar oils and gases which are, at present discharged into the atmosphere, is a rebuke to those who insist that we are still in the laboratory stage.

I have personally had convincing proof that coalite, the residual fuel of low temperature carbonisation, is not only a smokeless fuel, but also fulfils the requirements of the home-loving Briton for a companionable open fire.

Those local authorities who, in their anxiety to help forward smoke abatement, are giving the tenants of new housing estates no choice in the matter of heating and cooking agencies, might profitably do something towards educating the public in the uses of smokeless fuel in open grates and coal cooking ranges. These appliances must for many years provide the predominant means of cooking and heating in English homes. Personally, I am satisfied, in regard to smokeless fuel progress, that what Yorkshire does to-day, England will do to-morrow.

I am, Sir,

Faithfully yours,

(Sgd.) S. G. MOORE, M.D., D.P.H.,
Medical Officer of Health,
Huddersfield.

11 February, 1928.

PRACTICAL APPLICATIONS OF THE EARTH-CURRENT METER.

By BURTON MCCOLLUM AND K. H. LOGAN.
(U.S.A. Bureau of Standards.)

Because electrolytic corrosion of underground structures is roughly proportional to the leakage current which leaves these structures for the earth, an instrument for measuring this current is needed by engineers engaged in electrolysis testing and research. After several years of experimentation the Bureau of Standards has succeeded in developing an instrument for this purpose, and the results of its use in the field indicate that it is very satisfactory and of great practical value.

The instrument and accessories permit the determination of the resistivity and potential gradient of the soil adjacent to a pipe. A formula is developed for determining the rate of discharge of current by the pipe from these data. The formula involves a constant determined experimentally, and the method of determination of this constant is described.

Instructions are given for the several uses of the apparatus. The care of the instrument and the precautions necessary for obtainin greliable data are discussed.

In the last part of the paper the interpretation of data is considered and the results of field work are quoted to show that the earth-current meter gives more reliable information regarding electrolysis conditions than can be obtained otherwise.

BRITISH INDUSTRIES FAIR.

The well-known wide range of "Wellcome" Brand chemicals, which are universally accepted as products of exceptional purity and reliability, are represented by elegant specimens of bismuth and mercury salts and of quinine. Among fine chemicals, "Wellcome" Brand products occupy an enviable position, and representative of the latest advances are included in synthetic thyroxine, insulin and ergotoxine ethanesulphonate, also irradiated ergosterol which, of course, provides a ready means of administering Vitamin D. An array of alkaloids in the extraction of which Messrs. Burroughs Wellcome and Co. have for long specialised, is another important feature of altogether a most interesting display.

IMPORTANCE OF WOOD BLOCK PAVING.

Great care in the selection of timber, sorting and cutting is an essential to good work. Most important of all is the treatment by chemical means of the wood blocks after cutting. This treatment aims at the elimination of moisture and the impregnation into the pores and fibres of a suitable preservative, thus changing the state of the cellulose and lignim structure, and destroying the conditions favourable to the growth of the fungus *Lentinus lepideus.*

There are three principal methods of preservation :—

1. Zinc chloride ($Zn.Cl_2$) or Burnetising.
2. Bi-chloride of mercury ($Hg.Cl_2$) or Kyanising.
3. Creosoting.

The latter is the one most favoured to-day, and has the advantage, if properly carried out, of rendering the timber resistant to moisture, and more sanitary.

FORTHCOMING EVENTS.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

36, George Street, Manchester.

Tuesday, February 21, at 5.30 p.m.

Chemical Section.—Fiday, February 24, at 7 p.m.

PEOPLE'S LEAGUE OF HEALTH.

11, Chandos Street, Cavendish Square, London, W.1.

Wednesday, February 22, at 6 p.m.—"Fatigue and Sleep," by Sir Robert Armstrong Jones, M.D., D.Sc.

ROYAL INSTITUTION.

Tuesday, February 21, at 5.15 p.m.—Prof. J. S. Huxley : "The Behaviour of Animals."

Thursday, February 23, at 5.15 p.m.—Prof. F. Ll. Griffith : "Nubia in Antiquity and in the Middle Ages."

Friday, February 24, at 9 p.m.—Prof. George Gordon.

Saturday, February 25, at 3 p.m.—Mr. Campbell Dodgson : "The Life and Work of Albrecht Dürer."

ROYAL INSTITUTE OF PUBLIC HEALTH.

37, Russell Square, London, W.C.1.

Wednesday, February 22, at 4.30 p.m.—"Some Legal Aspects of Live Birth," by J. E. Whitley McFall, M.D.

THE ROYAL SOCIETY.

Thursday, February 23, at 5.30 p.m.

ROYAL SOCIETY OF ARTS.

John Street, Adelphi, London.

Monday, February 20, at 8 p.m.—Cantor Lecture. "Fatigue Phenomena," by H. Gough.

Wednesday, February 22, at 8 p.m.—"Recent Discoveries at Ur," by H. R. Hall, M.B.E., Dr.Litt. (of the British Museum).

THE ILLUMINATING ENGINEERING SOCIETY.

32, Victoria Street, London, S.W.1.

Tuesday, February 28—Inspection of E.L.M.A. Lighting Service Bureau, and Address by W. E. Bush, reviewing the activities of the Lighting Service Bureau.

UNIVERSITY COLLEGE.

Gower Street, London, W.C.1.

Monday, February 20, at 2 p.m.—"The French Chanson de Geste," by Prof. L. M. Brandin. (Public lecture.)

Wednesday, February 22, at 5.30 p.m.—"Humour in the Africaans Literature," by Mr. J. Haantjes.

Thursday, February 23, at 5.30 p.m.—"English Mediæval Painting." First of a course of public lectures by E. W. Trustram, F.S.A. Other lectures, March 1, and 8, same hour.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

2,331.—Balaban, I. E.—Manufacture of hydroxy-amino-phenyl-arsinic acid. January 24th.

2,844.—Chemical Engineering & Wilton's Patent Furnace Co., Ltd.—Apparatus for chemical treatment, etc. January 28th.

2,366.—Hirst, H. S.—Production of acetaldehyde. January 25th.

2,518.—Hyman, M. — Burette-reading device. January 26th.

2,718.—Schulemann, W. — Manufacture 6, alkoxy-8-aminoquinolines. January 27th.

Specifications Published.

258,887.—Lazette, Inc.—Method of effecting catalytic reactions for the production of ammonia.

265,224.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of isatins and n-arylsulpho compounds thereof.

270,711.—Permutit Akt.-Ges.—Process for the production of chromyl chlorides.

278,761.—I. G. Farbenindustrie Akt.-Ges. Manufacture of chlorine-substitution products of 1-amino-2 : 4-dimethylbenzene.

Abstract Published.

282,001.—4-Amino-2-benzoylbenzoic acid. Newport Co., Carrollville, Wisconsin, U.S.A.

4'-Amino-2-benzoylbenzoic acid is prepared by heating 4' halogen-2-benzoylbenzoic acid with aqueous ammonia under pressure with or without a catalyst such as copper or a copper salt. According to an example the sodium salt of 4'-chlor-2-benzoylbenzoic acid is treated with aqueous ammonia at elevated temperature under pressure in the presence of copper sulphate.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

PYRIDIUM.

484,454.—Dyes in class 4.—The Pyridium Corporation, 20, East 12th Street, New York City, New York, United States of America. January 25th.

QUINOXYL.

485,520. Chemical substances prepared for use in medicine and pharmacy. —The Wellcome Foundation, Ltd., 67, Holborn Viaduct, London, E.S.1. February 1st.

DAPHY.

486,555.—Chemical substances prepared for use in medicine and pharmacy. —Thomas Hale, 61, High Town Road, Luton, Bedfordshire. February 1st.

ORGAN-O-TONES.

486,713.—Chemical substances prepared for use in medicine and pharmacy. —Cole Chemical Co. 3727, Laclede Avenue, St. Louis, State of Missouri, United States of America. February 1st.

ENDELFLAT.

484,154.—All goods in class 1 which includes acids, potash, salts and other chemical substances used in manufactures.—Thos. Parsons & Sons, 315 and 317, Oxford Street, London, W.1.; and Works, Church Road, Mitcham, Surrey. February 1st.

POETRY OF SCIENCE.

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CONTENTS. PAGE.

Sodium Thio-Pyrophosphates 113
By H. E. Wallsom.
Australian Engineer's Account of a Visit to America 115
By R. M. Murray.
General Notes :—
Motor Spirit from British Coal 118
Natural Gas Production in Western Canada 119
Institute of Metals—Student Membership 120
Czechoslovak Foreign Trade 121
Proceedings & Notices of Societies :—
The Royal Society 122
The Chemical Society 123
Geological Society 124
Faraday Society 125
Notices of Books 125
Forthcoming Events 126
New Patents and Trade Marks 128

EAST LONDON COLLEGE USEFUL RECORD.

It is now twenty-two years since East London College was founded in the Mile End Road, London, and during that period it has steadily developed in usefulness and popularity. An evidence of its usefulness is the fact that it renders material help to graduates to find situations. It is run in connection with the London University, and its various activities are justly appreciated both by students and the inhabitants of East London. Its twenty-first birthday is to be celebrated on May 21 next, by a Conversazione, which the Duke and Duchess of York are to attend.

SODIUM THIO-PYROPHOSPHATES.

By H. E. WALLSOM.

The usual method for the preparation of ortho-thio phosphates (E. Glatzel, *Ber.*, 1891, XXIV, 3886; *Z. anorg. Chem.*, IV, 186) *consists in heating together a mixture of* metallic chloride with phosphorus pentasulphide, according to the equation :—

$$3MeCl + P_2S_5 = Me_3PS_4 + PSCl_3.$$

Another method consists in a reaction between the metallic sulphide and phosphorus tri- or penta-sulphide :

$$3Na_2S + P_2S_5 = 2Na_3PS_4.$$

L. Ferrand (*Compt. rend.*, CXXII, 886; *Ann. Chem. Phys.* (7), XVII, 338) heats together equivalent amounts of the metal, red phosphorus, and sulphur. No mention is made of the preparation of the sodium compound by this means.

In the present research certain thio-pyrophosphates have been obtained by the interaction of sodium sulphide, or hydrosulphide, *with phosphorus pentasulphide.* By this means di-, tri-, and tetra-sodium thio-pyrophosphates have been prepared.

$$2NaHS + P_2S_5 = Na_2H_2P_2S_7.$$
$$Na_2S + NaHS + P_2S_5 = Na_3HP_2S_7.$$
$$2Na_2S + P_2S_5 = Na_4P_2S_7.$$

The sulphur analogue of hexa-sodium meta-pyrophosphate :—

$$3Na_2S + 2P_2S_5 = Na_6P_4S_{13}.$$

and also sodium thio-orthophosphate :—

$$Na_2S + 2NaHS + P_2S_5 = 2Na_2HPS_4$$

have been obtained.

Equivalent amounts of anhydrous sodium sulphide, or hydro-sulphide, and phosphorus pentasulphide were ground together, and the mixture gently heated until it just fused. Excessive heating must be avoided, as far as possible, because of the tendency of those compousds containing hydrogen to lose it in the form of sulphuretted hydrogen ;

$$Na_2H_2P_2S_7 = 2NaPS_3 + H_2S$$
$$2Na_3HP_2S_7 = Na_6P_4S_{13} + H_2S.$$
$$2Na_2HPS_4 = Na_4P_2S_7 + H_2S.$$

PREPARATION OF SODIUM HYDROSULPHIDE.

This salt was prepared by the method given by Thomas and Rule (*T.*, 1911, *XCIX, 562). Sodium hydrosulphide* prepared by this method was found to contain about 0.1 per cent. impurity, presumably benzene.

Preparation of Sodium Sulphide.

Thomas and Rule (*T.*, 1913, ciii, 873) also gave a method for the preparation of pure anhydrous sodium sulphide, but the resulting compound contained sodium ethoxide. Thomas and Rule proposed to remove the excess of sodium ethoxide by washing with absolute alcohol, in which sodium sulphide is appreciably soluble.

An altogether better method was found to be that of Sabatier (*Ann. chim. phys.*, IV, (v) xxii, 65). This consisted in taking fused sodium sulphide, prepared in the usual method, and generally supposed to contain five molecules of water, making an intimate mixture of this with about 10 per cent. of pure sulphur, and heating in a small boat, placed in a glass tube, in a slow current of pure dry hydrogen. The sodium sulphide so prepared was faintly yellowish in colour, and very hydroscopic; it was easily decomposed in the presence of moisture. This sodium sulphide always contained about 0.2-0.4 per cent. excess of sulphur, which was not removed on further heating.

Preparation of Phosphorus Pentasulphide.

Equivalent amounts of red phosphorus and pure dry sulphur were intimately mixed in an iron crucible. A red hot needle was inserted, after which the reaction proceeded on its own account. The compound so prepared was yellowish in colour, and contained a slight excess of sulphur. Attempts to purify it by distillation in a current of dry carbon dioxide (Meyer and V. Meyer, *Ber.*, 1879, xii, 610) invariably led to the distillation of an almost white sulphide, of the composition P_4S_3 together with the excess of sulphur, which collected nearer to the mouth of the retort.

Methods of Analysis of Thio-pyrophosphates.

In all cases the sulphur and phosphorus contents of these salts were determined. The thiopyrophosphates were first oxidised, and the sulphur determined as barium sulphate, and the phosphorus as magnesium pyrophosphate. Several methods of oxidation were tried.

(1). *With fuming nitric acid and bromine.*—A weighed quantity of the salt, between 0.1 and 0.2 gram, was placed in a small stoppered tube, 0.7 cm. by 5 cms., and this in turn was placed with the stopper removed, in a stoppered test tube, containing the acid and bromine. The larger tube was then tilted so that the liquid came into contact with the contents of the smaller tube. After a few minutes the contents of the tubes was washed into a beaker, and the whole was boiled to get rid of the excess of bromine and nitric acid. This method was most generally used.

(2). *With sodium hypobromite.*—A strong solution of sodium hypobromite, *i.e.*, caustic soda and bromine, was placed in a beaker and a weighed quantity of the salt added. When the reaction was completed the excess of hypobromite was decomposed by hydrochloric acid. Whilst giving good results, this method necessitated a large bulk of solution, and was consequently but little used.

(3) *Fusion with sodium peroxide.*—A method, applicable to the estimation of sulphur only, which consisted in fusion with sodium peroxide and carbonate mixture, was also tried, but this did not yield quantitative results.

Analytical Results.

Tetra-sodium Thiopyrophosphate.

1.—(*a*) 0.1660 gram gave 0.0960 gram $Mg_2P_2O_7$; (*b*) 0.1838 gram gave 0.1006 gram $Mg_2P_2O_7$; percentage phosphorus, (*a*) 16.13; (*b*) 15.61; average 15.87. $Na_4P_2S_7$ requires 16.42.

2.—(*a*) 0.1326 gram gave 0.6124 gram $BaSO_4$; (*b*) 0.1708 gram gave 0.8010 gram $BaSO_4$; percentage sulphur, (*a*) 59.81; (*b*) 60.73; average 60.27. $Na_4P_2S_7$ requires 59.35.

Tri-sodium Thio-pyrophosphate.

1.—(*a*) 0.1734 gram gave 0.1118 gram $Mg_2P_2O_7$; (*b*) 0.1790 gram gave 0.1186 gram $Mg_2P_2O_7$; percentage phosphorus (*a*) 17.97; (*b*) 18.48; average 18.23. $Na_3HP_2S_7$ requires 17.43.

2. (*a*) 0.1410 gram gave 0.6710 gram $BaSO_4$; (*b*) 0.1835 gram gave 0.8864 gram $BaSO_4$; percentage sulphur, (*a*) 61.61; (*b*) 62.53; average 62.07. $Na_3HP_2S_7$ requires 63.04.

Di-Sodium Thio-pyrophosphate.

1.—(*a*) 0.1690 gram gave 0.1155 gram $Mg_2P_2O_7$; (*b*) 0.1812 gram gave 0.1246 gram $Mg_2P_2O_7$; percentage phosphorus, (*a*) 19.15; (*b*) 19.17; average 19.11. $Na_2H_2P_2S_7$ requires 18.58.

2.—(*a*) 0.1240 gram gave 0.6356 gram $BaSO_4$; (*b*) 0.1505 gram gave 0.7748 gram

$BaSO_4$; percentage sulphur, (*a*) 66.37; (*b*) 66.65; average 66.51. $Na_2H_2P_2S_7$ requires 67.17.

Hexa-sodium Thio-tetraphosphate.

1.—(*a*) 0.1698 gram gave 0.1088 gram $Mg_2P_2O_7$; (*b*) 0.1621 gram gave 0.1030 gram $Mg_2P_2O_7$; percentage phosphorus, (*a*) 17.85; (*b*) 17.71; average 17.78. $Na_6P_4S_{13}$ requires 18.30.

2.—(*a*) 0.1208 gram gave 0.5412 gram $BaSO_4$; (*b*) 0.1468 gram gave 0.6608 gram $BaSO_4$; percentage sulphur, (*a*) 61.76; (*b*) 61.82; average 61.79. $Na_6P_4S_{13}$ requires 61.45.

Di-sodium Thio-orthophosphate.

1.—(*a*) 0.1815 gram gave 0.1002 gram $Mg_2P_2O_7$; (*b*) 0.1708 gram gave 0.0966 gram $Mg_2P_2O_7$; percentage phosphorus, (*a*) 15.41; (*b*) 15.79; average 15.60. Na_2HPS_4 requires 15.06.

2.—(*a*) 0.1890 gram gave 0.6537 gram $BaSO_4$; (*b*) 0.1608 gram gave 0.7220 gram $BaSO_4$; percentage sulphur, (*a*) 61.70; (*b*) 61.66; average 61.68. Na_2HPS_4 requires 62.24.

These results indicate, as previously mentioned, that those compounds containing hydrogen, tend to lose this as hydrogen sulphide. It was found, by analysis, that, on heating, the salts di-sodium thio-pyrophosphate, tri-sodium thio-pyrophosphate, and di-sodium thio-orthophosphate yielded respectively, sodium thio-metaphosphate, hexa-sodium thio-metapyrophosphate, and tetra-sodium thio-pyrophosphate. In the case of the original salts the sulphur content was correspondingly lower than that required. With the remaining compounds, *i.e.*, tetra-sodium thio-pyrophosphate, and hexa-sodium thio-metapyrophosphate the sulphur content was too high, on account of the slight impurities in the sodium sulphide and phosphorus pentasulphide.

General Reactions of Thio-Pyrophosphates.

These compounds were easily decomposed in the presence of water, even in traces. They had very little smell, if perfectly dry, but after a few minutes' exposure to air there was a distinct smell of sulphuretted hydrogen. If thio-pyrophosphates were dropped into water sulphuretted hydrogen was at once evolved and bubbled off from the solution. At the same time sulphur was precipitated. Attempts to work out the exact course of the reaction of thio-pyrophosphates with water by adding a weighed quantity of the salt to water ,and collecting and weighing the precipitated sulphur, shewed that the amount of sulphur varied very considerably — sulphur sometimes being almost entirely absent, in which case the reaction must have proceeded according to the equation,

$$Na_4P_2S_7 + 7H_2O = Na_4P_2O_7 + 7H_2S,$$

and so on, with each salt.

This supposition was confirmed by the examination of the residue by the evaporation of the filtered solution. This residue contained no sulphur, but was composed almost entirely of the salt corresponding to the thiopyrophosphate. In this way it was found that :—

$Na_4P_2S_7$ gave $Na_4P_2O_7$.
$Na_3HP_2S_7$ gave indefinite results.
$Na_2H_2P_2S_7$ gave $Na_2H_2P_2O_7$.
$Na_6P_4S_{13}$ gave indefinite results.
Na_2HPS_4 gave Na_2HPO_4.

Thio-pyrophosphates gave a very peculiar reaction with alcohol. When the salt was mixed with absolute alcohol, it was expected that any phosphorus pentasulphide remaining unchanged would form mercaptan. This was never the case, shewing that definite salts were formed, and that the products were not mixtures of equivalent amounts of the original substances. However, with alcohol, thio-pyrophosphates always evolved a small amount of sulphuretted hydrogen, probably due to slight traces of moisture in the alcohol, and produced acetaldehyde, which could be recovered in small quantities by distillation. The final product of this reaction was not examined in detail. On boiling thio-pyrophosphates with alcohol sulphuretted hydrogen was evolved in fairly considerable quantities.

In conclusion it may usefully be pointed out that there is no reason to suppose that any of the salts described in this paper could have been detected by any method depending on the use of phase-rule diagrams. This method, although it has great utility in a number of cases, cannot be considered to be a general touchstone for the existence of salts and it is desirable that its limitations should be kept in mind.

East London College,

University of London.

AUSTRALIAN ENGINEER'S ACCOUNT OF A VISIT TO AMERICA.

By R. M. Murray,

General Manager of the Mount Lyell Mining and Railway Company Limited.

(Presidential Address delivered before the Australasian Institute of Mining and Metallurgy, at Queenstown, Tasmania, on May 26, 1927.)

Mr. Murray said:—"Having recently returned from a visit to America, it may be of interest to members to hear something from me of the mining fields and metallurgical works which I had the opportunity of seeing, and the impressions which I formed concerning general practice and conditions there, as compared with our Australian standards in the mining industry, and in matters generally.

The most striking feature of the North American continent is the huge plan upon which Nature has built, the multiplicity of immense mountains, rivers, and lakes, the snow-covered tops of the former forming reservoirs for the latter during the summer months, being most impressive to the Australian visitor. Starting from Vancouver I travelled east for over 500 miles through the wonderful Canadian Rockies, an endless panorama of mountain peaks and great rivers widening frequently into lakes, the mountain sides and valleys being covered with magnificent pine forests. Later in my tavels I saw something of these inland seas the Great Lakes, which incidentally give rise to the world-famed Niagara Falls, and finally I took my departure for England by way of that wonderful waterway, the St. Lawrence River, which is navigable by transatlantic mail boats for many hundreds of miles.

From the heart of the Rockies I travelled southerly into the United States, traversing Arrow Lake, a widening of the Columbia River, for over 100 miles, and also Lake Kootenev, and soon after crossing the frontier on the Western Highlands I saw the Missouri River, an immense stream which even here did not seem appreciably smaller than when I saw it as forming part of the Mississippi at New Orleans, over 3,000 miles away. The canyons in Utah and Arizona, and the Yosemite Valley in California, are on a gigantic scale, the enclosing cliffs of the latter rising a sheer 3,500 feet above the narrow valley, and amongst the waterfalls which cascade down these is one 2,400 feet in height, this distance being divided into two drops, the first being 1,800 feet. The foregoing are mentioned as giving an indication of some of the typical physical features, and Nature seems to have done everything on the same mammoth scale, providing in addition to almost unlimited water-power, mineral, coal, and oil deposits of huge extent and remarkable dissemination. The bigness of the works of Nature calls for a corresponding bigness in those of man, and throughout the country there is ample evidence that man has been equal to the requirements. This is evidenced in the realm of mining by the following:—

Mines and Works.

Sullivan Mine.—In British Columbia I had the opportunity of visiting the Sullivan mine at Kimberly, which is now one of the celebrated zinc-lead mines of the world. This is now being worked entirely from an adit 7,000 feet in length, the body being reached at that distance and opened up over a length of a mile without being delimited, its width being variable and reaching 600 feet. Its downward extension has been little explored so far. The underlay is extremely flat, and the ore required to be dragged down the foot-wall to the chutes. The nature of the ore is apparently very similar to that of the Rosebery mine, the zinc and lead sulphides being contained in a matrix of iron pyrites, there being very little insoluble gangue material. The grade, however is not so good as that of the Rosebery ore, the lead and zinc contents aggregating about 18 per cent. in nearly equal amounts. The mine is well equipped, mechanical shovellers being used for handling the ore on the ground floor, and transport is carried ont by means of electric trolley locomotives. The output is 3,200 tons per day, 500 men being employed. The ore is treated at the concentrating mill several miles away, this latter being a new installation of excellent lay-out. The metals are recovered by selective flotation, and an interesting feature is the recovery of a small amount of tin from the tailings by means of tables.

Trail Works (Consolidated Mining and Smelting Co.).—These are located on the Columbia River, whiih is here a fine stream about 1,000 feet wide, and produce electrolytic lead, zinc, and copper, and are both extensive and interesting, the old works being gradually replaced by new. The lead smelter produces 400 tons daily, of which 350 tons is electrolytically refined. The zinc plant has an output of 200 tons daily,

and the copper plant 30 tons daily. The power used amounts to 52,000 h.p., and is obtained from the West Kooteney Hydro-Electric plant at the cost of about one-tenth of a penny per unit.

Butte Mines.—This is one of the oldest mining fields, producing copper, lead, and zinc, but mainly the former, most of the mines being owned by the Anaconda Co., and worked in groups. An interesting feature of the copper group is a drainage level at the 2,800 feet horizon, which brings all the water to a common point for pumping. The output from these mines is about 8,000 tons of 4 per cent. ore daily, and is sent for treatment to the Anaconda works about 30 miles distant. Underground mining methods comprise both fill stoping and square-set stoping, both carried out on the lines similar to those in Australia. The copper obtained from the smelting of the concentrates in reverberatory furnaces is fire-refined and sent to Great Falls for electrolytic refining.

Great Falls Works.—These are remarkable works situated on the Missouri River, and comprise a copper refinery turning out 500 tons of refined copper daily, and an electrolytic zinc plant turning out 340 tons daily. In addition, the works comprise a rod and wire mill, which uses from 50,000 to 60,000 tons per annum of the refined copper.

Utah Mines.—Extensive copper and lead mines are situated in the vicinity of Salt Lake City, a splendid town in the basin of the old lake of that name, the waters of which have receded, the old beach level being visible on the mountain sides for miles around.

The Utah copper mine at Bingham is one of the most remarkable open-cut mines of the world, being situated on a mountain side, with working faces extending over 1,000 feet in vertical height, and a mile in length, the total vertical range of the ore-deposit approaching 2,000 feet. The average output is 34,000 tons of 1 per cent. ore daily, and this is transported to the concentrator in 80-ton trucks, which are tipped two at a time in a rotary tippler into a reciprocating jaw crusher. There are two concentrating mills, the larger having a capacity of 25,000 tons of ore daily. The concentrating process is entirely floatation, boxes of the Janney type being used. Wilfley tables were in use until recently, but have been discarded. The concentrates produced average from 15 per cent to 20 per cent. copper, and are transported to the Garfield smelter. The ore reserves amount to 500,000,000 tons, averaging 1.15 per cent. copper.

Inspiration Mine.—This mine is situated at Miami, Arizona, and provides a fine example of the caving system of underground mining, as does also the Miama mine adjoining. The output is 10,000 tons daily, and a special feature is the automatic winding engines which operate 12½-ton skips in vertical shafts, and have a capacity of 1,000 tons per hour. These winders are electrically operated by direct current from converter generator sets, and starting and stopping are automatically controlled from the skip charging bin in the mine. The men travel in a cage operated by a separate engine, and controlled by a man riding on the cage in the maner of an electric lift, winding engine drivers being entirely eliminated. Underground traction is carried out by means of compressed air locomotives and electric trolley locomotives, and on the surface storage battery locomotives are in use.

The grade of the ore is 1 per cent. copper, 0.8 per cent. being in sulphide form (mostly chalcolite), and the balance oxidised. Mining costs are less than 2s. per ton of ore delivered in the bins, and the total cost of producing copper for the year ended December ,1925, was £56 6s. per ton of fine copper. The concentrating mill treats 15,000 tons daily, the ore being ground in Marcy mills, of which there are 50, and treated entirely by flotation in Callow type boxes. cent. copper, the ratio of concentration being 40 per cent. and the recovery 95 per cent. The concentrates are smelted at the International smelter nearby in reverberatory furnaces, the resulting blister copper being sent to the Raritan works on the Atlantic coast for refining. A large leaching plant has just been completed, having a capacity of 7,500 tons daily. This will be used for the treatment of ores containing mostly oxidised copper, and assaying 1.25 per cent. total copper, including .85 per cent. oxidised copper. The recoveries are estimated at 100 per cent. of the oxidised copper, and 75 per cent. of the sulphide, and the expected cost of producing fine copper is £41 per ton. A pilot plant of 30 tons capacity has been used for experimental work.

New Cornelia Mine.—This is situated at Ajo, Arizona, not very far from the Mexican border. The mine consists of an open cut in comparatively flat country, having a length of 1½ miles and a width of three-

quarters of a mile, its contour being in marked contrast to that of the Utah mine. The concentrating ore assays 1.2 per cent. sulphide copper and 0.2 per cent. oxidised copper, the former in the form of chalcopyrite and a little bornite and chalcocite, very little iron pyrites being present. The ore sent to the leaching plant is mostly oxidised copper. The output is 6,500 tons per day of concentrating and 5,000 tons per day of leaching ore. The concentrating mill is a splendid example of a modern plant, the ore being ground in Marcy Rod mills and treated entirely by flotation in Callow boxes of the Inspiration type. The concentrates assay 33 per cent., the ratio of concentration being 23. Mining costs are 1s. 3d. per ton and concentrating 2s. 6d. Power is generated by oil-fired boilers and costs £10 per h.p. year. A special feature is the water supply, the mine being situated in an almost rainless district, and the water being pumped from a shaft 650 feet deep, situated some seven miles from the mine, the head being 1,400 feet. The supply is excellent both as regards quantity and quality and serves the township as well as the mines and works. The Calumet and Arizona Co., which owns the property, has done a great deal in the way of sociological activities, and has built much of the township, including a large store, which it conducts, churches, hospital, etc.

Copper Refineries.—The Raritan Copper works are situated at Perth Amboy, in New Jersey, and belong to the Anaconda Copper Co. These works have an output of 45,000,000 lb. of copper per month. The Chrome works belonging to the United States Metals Refinery Co., are situated some 12 miles distant, and have an output on a similar scale, as also has the American Smelting and Refining Co.'s works, also at Perth Amboy.

Oil Fields.—I had a most interesting visit to the oil fields in the Los Angeles district by the courtesy of the Standard Oil Co., and was very much impressed by the fine machinery in use for pumping the oil and dealing with the gases from the wells, and surprised at the proximity of the oil wells to one another.

Hygienic Conditions and Sociological Activities. — Generally speaking, the hygienic conditions are not up to the standard of what we are used to in best practice in Australia. The prevention of dust in the mines and works, although receiving attention, is not so far advanced. First aid work is a feature on most mines and works.

There is not a very great deal done in the way of sociological work, such as the establishment of workmen's clubs, etc., although a fine institution of this description exists at the Great Falls works. Baseball teams are subsidised in places as means of promoting entertainment, and companies stores are also in evidence, there being an excellent one at Trail and a very large one at Ajo, at each of which places hospitals are built and subsidised by the coipanies.

The features that stand out with the greatest prominence are the following :—

In Ore Concentration—

1. The huge scale of operations and the extremely low grade of ore which is treated with profit by concentration and smelting.
2. The high ratio of concentration which is obtained (up to 50 to 1), this being brought about by the use of lime as a selective agent, and anthate and similar reagents.
3. The small quantities of flotation reagents which are used per ton of ore.
4. The almost entire superseding of gravity concentration by flotation in copper milling.
5. The elimination of mechanical agitation in the flotation proces and the substitution of compressed air.
6. The low cost of treatment.

In Smelting—

1. The universal use of the reverberatory furnace.
2. The use of oil or pulverised coal as fuel.
3. The low cost of smelting per ton of concentrates (ranging from 6s. to 8s. in the large plants to 15s. in the smaller ones).

General.—A striking feature is the cleanliness and tidiness maintained in and about the mines and works.

As to underground mining, Australian practice fully holds its own.

(*To be continued.*)

GENERAL NOTES.

MOTOR SPIRIT FROM BRITISH COAL.

Engineer Predicts Future of Enormous Possibilities.

That the commercial production of motor-spirit from British coal is already an accomplished fact was revealed by Lt.-Col. W. A. Bristow, M.I.E.E.E., at Sheffield.

Speaking at a luncheon held on Thursday, February 2, to make the commercial

development of low temperature carbonisation in Yorkshire, he claimed that this process stood now, for the first time, on the threshold of enormous possibilities.

Sir Arthur Wheeler, chairman of Low Temperature Carbonisation, Ltd., presided, and the guests included the Lord Mayor Alderman M. Humberstone), Medical Officers of Health from Northern and Midland cities, and representatives of the Sheffield and Rotherham Joint Smoke Abatement Committee—the first regional committee formed to deal with smoke abatement under the new Public Health Act.

The sucess achieved by the coalite process in Yorkshire, said Col. Bristow, had caused a deluge of requests for the taking over of various other processes which, it was claimed, would make fortunes in a few months, but it was found that, in none of these cases were those claims suported by figures obtained from test runs on production plants.

Colonel Bristow said that Royal Commissions, eminent politicians, and scientists had caught the habit of presaging low temperature carbonisation as a fuel revolution of the *distant* future, which at one fell swoop was going to save the mining industry, sweep away fogs and provide abundant resources of power and material for industry. But always the ideal was clouded by the phrase " if only it were commercially practicable." This kind of inverted Coué-ism was most mischievously sowing the seed of public mistrust of a signal achievement.

He proceeded : " They are also undermining the confidence of British capitlists by mysteriously hinting at marvellous German and American systems of low temperature carbonisation while here in Britain, miles ahead of Germany or any other foreign country. South Africa, Chile, Germany, Australia, and India have all sent samples of their coal to the Yorkshire works in order to see if it is suitable for treatment by the coalite system.

" Speaking with exact knowledge of the Barnsley low temperature works I give you some salient facts :—

' Already we are delivering into the railway trucks as fast as we can produce it an almost perfect smokeless fuel.

Aeroplanes can be flown and motor engines can be run by the spirit derived from coal, which we are also selling as fast as we can produce it.

The power for our power house and the whole of the gas for heating the retorts is released from the some coal and there still remains sufficient gas to provide light or heat for a good sized village.

All the tar oils derived from the coal are sold for months ahead and are being delivered direct into the railway tanks.'

" Arrangements have just been completed," concluded Colonel Bristow, " for the dispatch of British coalite to Denmark, where fuel merchants are so interested in its success that they have decided to push it against the German patent fuels of which they import large quantities. The first export shipment of low temperature carbonisation fuel will actually leave Hull in a few days' time."

Mr. W. Asbury, chairman of the Sheffield and Rotherham Joint Smoke Abatement Committee, declared that after personal experience, he was convinced that if adequate supplies of smokeless fuel were assured, responsible advocates of smoke abatement would feel justified in pressing upon the Government the prohibition of the burning of raw coal in domestic grates.

February 4, 1928.

SAFEGUARDING OF KEY INDUSTRIES.

The Board of Trade give notice that representations have been made to them under Section 10 (5) of the Finance Act, 1926, regarding ethyl lactate, R potassium chlorate and R titanium oxide.

Notice is also given that the Treasury have made an Order under Section 10(5) of the Finance Act, 1926, exempting crude cocaine from Key Industry Duty from 11 February, 1928, to 31 December, 1928, and continuing till 31 December, 1928, the exemption from duty of R acetone, acetone fermentation, acetone synthetic, acid oxalic, amidopyrin, ammonium perchlorate, barbitone, dial, didial, elbon, ethylene bromide, ethylene glycol, furfurol, glycol ethers, guaiacol carbonate, hydroquinone, integrators (planimeter type), R lead acetate, lead tetra-ethyl, lipoiodin, methyl sulphonal, phenacetin, phenazone, phytin, piperazine, planimeters, R potassium hydroxide, potassium hydroxide, potassium guaiacol sulphonate, pyramidon-veronal, salol, sulphonal, urea.

UNITED STATES TRADE CONDITIONS.

Wholesale trade in the United States during 1927 was 3.6 per cent. under that of 1926, states a cable received by the London

office of the Guaranty Trust Company of New York. Business failures in 1927 totalled 23,146, against 21.773 in 1926; liabilities were $520,104,000 against $409,232,000. December earnings of 30 railroads were 27.7 per cent. below those of the final month of 1926.

THE INSTITUTE OF METALS.

"STUDENT" MEMBERSHIP OF THE INSTITUTE OF METALS.

In order to encourage metallurgical and engineering students, under the age of 23, and those of a similar age working under persons who are qualified for membership of the Institute, to take an interest in their professional society, and to obtain the literature which they require in their studies, there exists a class of member of the Institute of Metals which is known as "Student" Member.

"Student" Members of the Institute of Metals have all the advantages of full members, with the exception that they have no voting power. They receive, free, the two bound volumes of the "Journal," which are issued annually, and all the other publications of the Institute. They are able to borrow any book contained in the library and to obtain many other advantages which the full member of the Institute has.

"Student" members pay an annual subscription of only £1 1s. (instead of £3 3s. paid by a full member) and an entrance fee of £1 1s. (instead of £2 2s. paid by a full member).

The Council very much hopes that a greater number of persons who are qualified for "Student" membership will join the Institute in the coming year. At the present moment the majority of the "Student" members come from the metallurgical and engineering departments of the Universities. It is hoped that those studying in the technical colleges, and others working in metallurgical and engineering establishments, will also take advantage of this low subscription and join the Institute.

Application forms for "Student" membership can be obtained from the Secretary, The Institute of Metals, 36, Victoria Street, London, S.W.1. Elections take place on February 22, and April 11, next. The subscriptions of "Student" members whose forms go forward at these elections will cover them until June 30, 1929, and in addition to the usual two bound volumes of the "Journal" received by them in return for their annual subscription, they will receive a copy of the "Journal" which is to be issued in June next.

TECHNICAL COLLEGE, GLASGOW.

On October 18, 1927, the annual report of this College for the session 1926-27 was adopted by the Governors. The session covered by the Report was rather depressing owing to the depression which prevailed in several local industries, especially shipbuilding and engineering. Fortunately, things are now slowly improving. During the session the number of day students was 934, and of evening students 3,235, making a total of 4,169, or 20 more than the number in the previous session, the student hours being respectively 607,624 and 585,148. Among a range of about a score of departments the enrolments in the mechanics and the mechanical engineering department at 1,516, was the highest followed by chemistry with 1,224 entrants. The total receipts amounted to £74,975 8s. 2d., and the expenses £3,985 14s. 1d. less than that sum. A long list is published of those who gained distinctions during the session, and this gives some indication of the wide range of subjects taught in the College, as well as the efficiency of the instruction given.

ROYAL INSTITUTION.

A general meeting of the Members of the Royal Institution was held on Monday afternoon, February 6, Sir Arthur Keith, Treasurer and Vice-President, in the chair. The Secretary announced the decease of Professors H. A. Lorentz and H. von Groth, Honorary Members of the Institution, and resolutions of condolence with the relatives were passed. The special thanks of the Members were returned to Mr. J. G. Gordon for his donation of £200 to the General Fund, to Mr. Robert Mond for his valuable gift of the surviving portion of the original M.S. of Faraday's Chemical Manipulation, and to Professor E. C. C. Baly for the first sugar syrup synthesised from carbonic acid, and to the Executors of the late Count Vay de Vaya for their present of his bust, in commemoration of his Friday evening discourse at the Royal Institution in 1904. Lord Swinfen, Earl Iveagh, Rt. Hon. . C. C. Davidson ,E. H. Collins, J. J. Fox, Miss F. E. Gollan, Mis C. W. Harvey, Charles Hogg, John Lea, Miss T. C. Marwick, Dr. Walter Rosenhain and Mrs. Sanderson were elected Members.

IMPERIAL CHEMICAL INDUSTRIES.

Imperial Chemical Industries Limited have made an offer to the Tees Salt Company Limited, who own a salt business at Haverton Hill-on-Tees, Co. Durham, near the works of Synthetic Ammonia & Nitrates Ltd., to acquire the shares of that company on the following basis of exchange :—

10 I.C.I. £1 7 per cent. Cumulative Preference Shares for each £10 Tees Salt Preference Share.

10 I.C.I. £1 Ordinary Shares for each £10 Tees Salt Ordinary Share; plus a cash payment of 5s. for each Tees Salt Ordinary Share.

The offer is conditional upon it being accepted by the holders of 75 per cent. of each class of Tees Salt shares.

CZECHOSLOVAK FOREIGN TRADE IN 1927.

Figures have now been issued by the Czechoslovak Bureau of Statistics showing the volume and value of exports and imports for the year 1927, compared with 1926.

The total value of the exports in 1927 amounted to 20.127 million crowns, and that of the imports 17.857 millions, so that the trade balance was favourable to the extent of 2,197 millions, as compared with a balance of 2,580 millions in 1926. The main items of export were :

	In million crowns.	
	1927.	1926.
Cotton yarns and fabrics ...	3.071	2.484
Sugar	1.525	2.247
Wollen yarns and fabrics ...	2.085	1.611
Iron and iron goods	1.619	1.254
Grain	1.000	781
Leather and leather goods	1.093	701
Glass and glassware ...	1.143	1.169
Fruit and vegetables	643	730
Coal	976	1.097
Timber	1,056	655
Silk and silk goods	588	421
Flax, hemp, jute yarns ...	722	574
Porcelain	459	876
Base metals and wares ...	407	328
Machinery and apparatus...	407	338
Clothing & made-up articles	590	526
Paper and paper goods ...	448	375
Animal products	275	222
Minerals	253	190

There was, it will be seen, an increase of 586 millions in cotton exports, of 474 millions in woollen exports, and increases of 166, 147 and 63 millions respectively in the exports of silk, linen, etc., and clothing. In all, textile exports showed an advance of 1,436 million crowns on the figure for 1926. Notable also was the growth in exports of leather and leather goods by 392 million crowns. Sugar exports declined by the very considerable amount of 722 millilons.

£1 is equivalent to 164 Czech crowns.

The leading items of import were :—

Raw cotton	2,197	1.757
Yarns and goods	462	367
Grain, flour, malt, pulse, rice	2.172	1.870
Raw wool	1.622	1.231
Yarns and goods	418	342
Base metals	592	529
Silk and silk goods	727	554
Tobacco	418	463
Fruit and vegetables ...	649	585
Cattle	721	602
Fats	626	628
Flax, hemp, jute	550	427
Iron and iron goods	518	422
Machinery and apparatus...	473	462
Coal	414	362
Mineral oils	369	333
Minerals, ores	433	401
Leather and leather goods	280	218
Electrical machinery and apparatus	255	214
Rubber and rubber goods	284	208
Watches, clocks, instrum'ts	204	161

The increase in imports is due largely also to the textile trade, raw cotton imports showing an advance of 440 million crowns, and wool imports an advance of close upon 400400 millions. Despite the corn duties, imports of grain and flour likewise show an increase. The only drop of any consequence was in tobacco imports.

DISTRIBUTION OF OUR TRADE IN 1927.

An analysis of the geographical distribution of our overseas trade during last year shows that the value of imports from Empire sources was 26.87 per cent., as compared with 29.63 per cent. in 1925 and 24.87 per cent. in 1913. Exports of British produce to Empire destinations amounted in value to 42.56 per cent. of the total, as against 39.18 per cent. in 1925 and 37.18 per cent. in the last full year before the war.

PRICES IN FRANCE, GERMANY, ETC.

The indices for Italy, France and Belgium for December last as compared with December, 1926, show falls of 18.3 per cent., 3.6 per cent., and 2.2 per cent. respectively, while the German index number records a slight advance (1.8 per cent.).

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.

The following papers were read at the meeting held on Thursday, February 2:—

The Air-Resistance to a Runner. By A. V. Hill, F.R.S.

The air-resistance to a model of a running man has been measured in a wind-channel, and found to be $0.45\ \rho v^2A$, where ρ is density of air, v relative velocity, and A projected area of model in direction of motion. This is $0.00170\ v^2A$ lbs. weight (v feet per sec., A sq. fa. . The projected area of a runner is approximately = square of his height × 0.15.

From these data the air-resistance can be calculated. For a runner on a still day the air never provides more than 5 per cent. of total resistance, the remainder being in his own muscles and limbs. A following wind of 10 miles per hour will increase speed about 3 per cent., a similar head-wind will diminish speed about 5 per cent.

A table is given of air-resistance experienced at various speeds, and the effect of cross-wind discused. It is shown that the correction for air-resistance is too small to affect materially the equations previously found for acceleration of runner at beginning of a race.

On the Embryology of a Mysid Crustacean, Hemimysis Lamornæ. By S. M. Manton. Communicated by J. S. Gardiner, F.R.S.

Germ layers and general rudiment are differentiated externally on germinal disk. Gastrulation takes place by immigration from a blastoporal area. The spatial relations of germ layers in Malacostraca are fundamentally different from lower Crustacea, in both yolky and non-yolky forms. 15 ectodermal teloblasts lie in anterior lip of blastopore and form ectoderm of trunk region.

The mesoderm forms in three ways. A row of eight mesodermal teloblasts give rise to the trunk mesoderm : a pair of head bands of mesoderm supply the naupliar segments and in front of these a pair of preantennulary somites is formed. Cœlomic cavities appear in all, except antennulary, mandibular and maxillulary segments. Walls of the preantennulary cœlomic sacs form stomodeal musculature and anterior aorta, just as in *Limulus* and Spider. A dorsal vessel is developed from maxillary cœlomic sac backwards, much as in Estheria, and a " cardiac plug " is formed, as in Chirocephalus. A s eventh pair of mesodermal somites and a ganglion lie behind the sixth. In adult the sixth abdominal segment represents fused sixth and seventh segments, the uropods being the sixth abdominal limbs.

The yolk cells or vitellophags represent true endoderm. They form secondary yolk pyramids and give rise directly to mid-gut epithelium. The liver is formed from posterior parts of head mesoderm bands.

Endoskeletal system is ectodermal, and consists of (1) hollow ectodermal in-tuckings of nature of apodemes, and (2) transverse segmental bars which separate from ectoderm forming median tendons of mandibular adductor and trunk mesodermal muscles. Much of the musculature is ectodermal in origin. The antennal gland is mesodermal, except for short ectodermal exit tube.

Immunological and Serological Studies on the Viruses of Fowl-Pox and Vaccinia. By G. M. Findlay. Communicated by J. A. Murray, F.R.S.

Three strains of fowl-pox virus bave been studied : two are pathogenic for the fowl only; one is pathogenic for fowl and pigeon. All attempts to render these three strains pathogenic for rabbits, rats, calves and ducks have failed. One attack of fowl-pox produces immunity. In the fowl any one of the three strains completely immunises against the others, but in the pigeon previous treatment with the strains pathogenic for fowl produces only partial immunity against the strain pathogenic fo rpigeon and fowl.

Vaccinia virus passaged in the fowl does not become converted into fowl-pox virus, and remains pathogenic for rabbit and rat. Vaccinia virus and fowl-pox virus do not show any cross-immunity in the hen. Anti-vaccinia serum from hen has no viricidal action on virus of fowl-pox, nor has anti-fowl-pox serum viricidal action on virus of vaccinia. While fowl-pox cirus easily passes through a Berkefeld filter, vaccinia virus, even after repeated passage in the hen, is still largely held back.

No evidence was obtained showing any close relation between virus of vaccinia and the three strains of fowl-pox virus investigated. The factors underlying the Calmette-Guerin phenomenon are discussed.

THE CHEMICAL SOCIETY.

Thursday, February 16.

China Wood Oil. The Oxidation of β-elæostearic Glyceride. By R. S. MORRELL AND S. MARKS.

The conditions of oxidation of β-elæostearic glyceride in a current of oxygen have been investigated and a dihydroxy-peroxide,

$$\begin{array}{l} CH_3.(CH_2)_3.CH.CH.(CH_2)_2.C : C.(CH_2)_7COOGly \\ \qquad\qquad\quad | \quad\ \ | \qquad\qquad\qquad\ \ \vdots \quad\ \vdots \\ \qquad\qquad\quad O\,.\,O \qquad\qquad\quad H\ \ O\ \ OH \end{array}$$

has been isolated. Methods of determination of hydroxyl and peroxide groupings have been revised and the results are in keeping with the proposed formula. Uniou with piperidine is followed by decomposition at the peroxide grouping remote from the glyceride group. A piperidine additive product or a glyceride of a C_{13}-aldehydo-acid was isolated. The combination of piperidine with drying oils has been investigated, especially with reference to combination of the base with β-elæostearic glyceride. Methylation of the oxidised glyceride has been effected without rupture of the carbon chain. From the distillation products of the methyl ester a dimethoxy-methyl aldehydo-ester,

$$\begin{array}{l} CHO.(CH_2)_2.C : C.(CH_2)_7.COOCH_3 \\ \qquad\qquad\quad\ \ | \quad\ \ | \\ \qquad\qquad\ CH_3O \ \ OCH_3 \end{array}$$

has been isolated.

The formula put forward for the initial state of the oxidation product of the glyceride explains a number of the characteristics of drying oil films.

Cryoscopic Evidence of Compound-formation in Mixtures of Organic Liquids. By W. M. MADGIN, J. B. PEEL AND H. V. A. BRISCOE.

Evidence is submitted that certain binary liquid mixtures, especially those giving a considerable rise of temperature of mixing, contain compounds. Separate solutions of the two liquids in a solvent (benzene, nitrobenzene or bromoform) are prepared such that they exhibit the same depression of freezing point. If on admixture the depression of freezing point is *less* than in the separate solutions, clear evidence, independent of theories or calculations, is obtained that the solutes have combined.

Thus, it has been shown that, even in comparatively dilute solutions, compounds are formed by the pairs of liquids : *o*-chlorophenol-pyridine; *o*-chlorophenol-aniline; *o*-chlorophenol-ether; chloroform-ether; chloroform-acetone; bromoform-acetone; acetone-carbon disulphide.

The Preparation and Properties of Selenophen and Certain Halogen Derivatives of Selenophen. By H. V. A. BRISCOE AND J. B. PEEL.

Selenophen ,differing greatly in properties from a substance previously described as known, has been separated from the proselenophen (Foa, *Gazzetta*, 1909, xxxix, 1909, 527), and hence, apparently, unduct of the action of acetylene on selenium at about 400° in an electrically heated silica tube. *Selenophen*, C_4H_4Se, a colourless mobile liquid, which readily burns in air with a bright blue flame from which selenium is deposited on a cold surface, is insoluble in water, but is miscible in all proportions with acetone, benzene, and carbon disulphide.

Selenophen has a density of 1.5307, b.p. 109.9-110.1°/752.1 mm. f.p. -38°. In chemical properties selenophen resembles thiophen; it is neither oxidised by permanganate in acetone solution nor reduced by hydrogen in presence of reduced nickel at 250°. It is unaffected by boiling with water, sodium hydroxide solution or concentrated hydrochloric acid, and does not react with methyl iodide at 160°. It reacts vigorously with sulphuric or nitric acid but the sulphonic and nitro-derivatives apparently produced have proved difficult to investigate. In carbon disulphide solution at the ordinary temperature bromine and chlorine react smoothly and easily to give the tetra-halogen derivatives.

Tetrabromoselenophen, C_4Br_4Se, white, m.p. 102, is stable towards an acetone solution of permanganate, but boiling water decomposes it slowly with deposition of selenium. *Tetrachloroselenophen*, white, is much less stable than the bromo-derivative, decomposing either in the solid state or in solution at about 85°. It also decomposes slowly on keeping at laboratory temperature, evolving an acid gas; when warmed with water or dilute acids it easily breaks down depositing selenium.

A Case of the Spontaneous Resolution of Externally Compensated Mixtures. By L. ANDERSON AND D. W. HILL.

Atropine sulphate, whether prepared by racemisation of *l*-hyoscyamine or semi-syn-

thetically, that is from synthetic tropic acid, *can be resolved by fractional crystallisation* from alcohol into *l*- and *d*-hyoscyamine sulphates.

GEOLOGICAL SOCIETY OF LONDON.

On January 25 (Dr. F. A. Bather, M.A., F.R.S., presiding), the following communication was read :—

The Glacial Retreat from Central and Southern Ireland. By PROF. JOHN KAYE CHARLESWORTH, *D.Sc., Ph.D., M.R.I.A.,* F.G.S.

The Newer Drift of Ireland is bounded on the south *by a broad and well-developed* kettle-moraine the 'South Irish End-moraine' which runs from the vicinity of Wexford round the northern flanks of the Dublin Hills and by way of Baltinglass, Bennettsbridge, Cahir, Tipperary, Charleville, and Newcastle West to the mouth of the Shannon, a distance of 310 miles from coast to coast.

Contemporaneous with this stage of the *Ivernian Ice and* the Irish-Sea Ice were the independent ice-centres in the Kerry and Wicklow Hills, the Comeraghs, Galtees, Knockmealdown, and other mountain-clusters of the south. Their extent is likewise indicated by well-marked outer moraines, and *corresponds to a snow-line* on *northern and* eastern *slopes of about* 1,000 feet and on other slopes of approximately twice that altitude.

The Irish glacial fauna is resticted, with but few exceptions, to the region outside these moraines.

The ice-recession from the Dublin and Wicklow Hills is clearly shown by moraines and marginal drainage-features. These prove a pivoting of the ice on the northern *slopes of the hills, immediately* south of Dublin, and the sweeping of the ice-fronts to east and west, at successive stages of the retreat, in a series of curves which swing out of each other tangentially and northwards.

The dissolution of the Ivernian Ice-sheet caused the emergence of the higher hills, such as the Castlecomer *Plateau, the Slieve* Bloom and Keeper Hills, and the formation of large lobes protuded southwards down the intervening valleys. The moraines of the Barrow, Nore, Suir, Shannon, and other lobes are magnificently displayed, making possible the correlation from lobe to lobe and the delineation of the succesive positions of the ice-margin across the country from coast to coast. The festooning *of the moraines in the southern* part of the country is governed by the relief, while their sinuous form in the northern region is to be ascribed to the break-up of the ice-sheet into separate lobes, flowing on roughly parallel lines.

The ice-sheet in its recession over Southern Ireland remained pivoted on the Dublin hills, and retreated over ever-widening strips of country as the ice-front is followed westwards; a withdrawal of 65 miles in the west is represented south of Dublin by but a few hundred yards.

The ice retreating over the Central Plain was dissected into three perfectly distinct lobes, which centred upon the mountains of Donegal, Leitrim, and Galway respectively. *Their stages of recession are indicated by* countless moraines, the "eskers" of Irish Glacial literature. True osar occur subordinately, transversely within, and as integral parts of, the kettle-moraines.

DISCUSSION.

Prof. J. W. Gregory congratulated the author on his paper, and especially on its important contribution to the correlation of the glacial drift of South-Eastern Ireland. He welcomed this confirmation of the marginal origin of the main eskers, which was the chief contention in his own paper of 1920 on the Irish Eskers. The motive of that paper was to show that the eskers were *inconsistent with the great ice-dome, which,* in analogy with Greenland, was *supposed* to have been piled over the Irish plain. The Author has proved that where that ice-dome should have been almost at its thickest, the ice was less than 400 feet thick. The ice flowed from the mountains down to the plain, and not from the plain up the *mountains. As* the ice-dome over Central Irish plain was the main support for the theory of the supposed ice-dome over the Irish Sea, the abandonment of the one would probably be followed by that of the other.

Professor P. F. Kendall said that the Author was either very right or very wrong. He referred to the early work of Maxwell Close on glaciation in Ireland, and traced the changes *in the explanations of the origin* of eskers which had been put forward by various authors. Professor Gregory had been the first to suggest that eskers were marginal. With the main lines of Professor Gregory's 1920 paper he agreed, but certain small addenda to Professor Gregory's view *he was unable to accept.* The phase of the glaciation studied by the Author did not

involve the complete glaciation of Ireland. The whole of Ireland was once, completely submerged beneath ice, as the Author had said. Accordingly, there was no need to abandon the idea of an ice-dome over Ireland, and the same might be said of the ice-dome over the Irish Sea. He thought that the Author had demonstrated the reality of the glacial retreat. He suggested that the marked phases in the retreat must have their equivalents in Great Britain.

Dr. A. R. Dwerryhouse particularly welcomed the demonstration of the fact that the presence of the Irish Sea ice on the western shore of St. George's Channel was contemporaneous with the outermost kettle-moraine of the Irish ice, and hoped that this fact might be of use in the futher elucidation of the problems of the glaciation of parts of Central Wales, on which he was at present engaged.

Dr. Bernard Smith said that workers studying glaciation on this side of the Irish Sea must envy the Author the field in which he had carried out his investigations, where remarkable sequences of moraines extended for so many miles at a strech. Working on the Welsh Borders and in the Lake District, he himself could point out out probably not more than one distinct moraine that extended continously for over a mile as an independent unit; and, speaking generally, closely detailed mapping of the phenomena of retreat was necessary to obtain any results of value.

One major stage of retreat, followed by an important re-advance and a second retreat, had been determined in Cumberland. The latter was probably that which followed the re-advance postulated by the Author, when ice re-invaded the Carlisle Basin and extended nearly to the Pennines as determined by the speaker's colleagues.

MAXIMA ON CURRENT-VOLTAGE CURVES.

ELECTROLYSIS OF NICKEL SALT SOLUTIONS WITH THE MERCURY DROPPING KATHODE.

By N. V. EMELIANOVA AND J. HEYROVSKY.

(*Faraday Society, January* 25, 1928.)

When plotting the intensity i of the electrolytic current against the polarising E.M.F., the resulting current-voltage curves ("polarisation curves") usually slope up without showing any reproducible maxima or minima. However, the special sensitive method of electrolysis with the mercury droping kathode, which enables us to follow kathodic processes and to get exactly reproducible results, reveals, under certain conditions, a sudden discontinuous fall of the current. This phenomenon is specially shown when the polarisation curves are recorded automatically by means of the photographic recording instrument, the "Polarograph."

SUMMARY.

1. Polarisation curves of electro-reductions obtained with the mercury dropping kathode show very prominent maxima, the nature of which was specially studied in electro-deposition in nickel salt solutions.

2. With pure nickel salts a maximum appears only when the solutions are carefully freed from atmospheric oxygen.

3. Additions of electrolytes cause a suppression of the maximum, the suppressive effect of various kations being identical with their coagulating effect upon negative suspensoids; the effect of traces of fuchsin, also, is considerable.

4. The phenomenon of the maximum is shown to be due to the adsorption of the reducible matter at the mercury solution interface and the suppression of maximum to be due to the replacement of the reducible ions by other adsorbable matter.

5. The sudden fall of the current after the maximum is explained by the formation of the layer exhausted as to nickel ions, at the instant when the velocity of deposition of ions is greater than the velocity of adsorption in the surface film at the mercury cathode. As a sequence of the fall of current the polarisation sets in.

NOTICES OF BOOKS.

Où en est la Chimie Industrielle. Par A. CHAPLET (Ingenieur Chemiste). Pp. 286. Price, 25 francs. Paris: Gauthier-Villars et Cie., Quai des Grands-Augustins 55.

This is an eminently practical book, by one who has obviously a wide knowledge of metallurgy and chemistry. The book is written in clear (French) language, while numerous illustrations help to still further elucidate the context, which is really never obscure. The work ought to have a wide circle of readers.

Weeds of South Africa.

The Department of Agriculture, Union of South Africa, has issued several bulletins, (by K. A. Lansdell), dealing with the various weeds of South Africa and shewing how best to cope with the pest.

Organic Syntheses. (An Annual Publication of satisfactory methods for the preparation of Organic Chemicals; prepared by an influential Editorial board and over a score of specialist contributors.) Pp. 106. Price, 7s. 6d. New York: John Wiley & Sons, Inc.; and London: Chapman and Hall, Ltd., 11, Henrietta Street, W.C.2.

This is Vol. VII. of the very useful series published under the above title. That it is an advantage in having the co-operation of a large number of competent authors in the preparation of a volume of the scope of organic syntheses will be admitted by all practical chemists, and if there were any doubt about the matter it would be dispelled by even a cursory perusal of the volume before us. It ought to prove serviceable to many and will be certain to command, as it richly deserves, wide popularity among students and practical chemists, and more especially when the moderate price at which it is published is taken into account.

Standards and Tests for Reagent and C.P. Chemicals. By BENJAMIN L. MURRAY, Member of the American Chemical Society, Chemical Society (London), etc. Second edition, revised and enlarged. Pp. XIII + 560. Price 25s. net. London: Constable and Company, Ltd.

It is very rare to find a book which is not capable of improvement when a second or subsequent edition comes to be prepared. This rule applies to chemistry probably more strongly than to any other subject, owing to the ever-widening field of discovery in which so many authors are labouring. Hence the second edition of the present important work is an improvement on the first edition. This is of course, no disparagement of the worth of the first edition. Modifications have been made in certain parts of the text, while desirable additions have been made with material advantage to the reader, be he manufacturing chemist, experimenter, or general reader. The work is important and deserves a prominent place in any scientific library.

AMERICAN PHOTOGRAPHY.

The American Annual of Photography. 1928. By F. R. FRAPRIE. Pp. 224. Price 7s. 6d., paper; 10s. cloth.

The 42nd volume of the *American Annual of Photography* contains not only nearly a hundred selected examples of the photographic art, but also a series of articles dealing with many aspects of the subject. From the style of presentation these are apparently written more for the amateur than for the technician. Some, nevertheless, contain valuable information and all may be said to be useful. Reference may be made to "Photographic Sensitivity and the Latent Image," by E. P. Wightman; "Photography through the Microscope," by Wightman and A. P. H. Trivelli; "Hypersensitising Plates," by E. J. Wall. Mr. Wall also conducts the *Photographic Review.*

The Annual can be obtained from Messrs. B. T. Batsford, 94, High Holborn, London, W.C.

FORTHCOMING EVENTS.

INSTITUTE OF METALS.

Birmingham Local Section, at the Engineers' Club, Waterloo Street—Thursday, March 1, at 7 p.m.—"Gases in Metals." By Prof. C. A. Edwards, D.Sc.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

Tuesday, February 28, at 8.30 p.m., at the House of the Royal Society of Arts, John Street Adelphi, W.C.2.—109th General Meeting. "Flame Characteristics of Pinking and Non-Pinking Fuels." By Professor R. V. Wheeler, D.Sc., M.Inst.P.T., and Dr. G. B. Maxwell. The chair will be taken at 8.30 p.m.

PEOPLE'S LEAGUE OF HEALTH.

11, Chandos Street, Cavendish Square.

Wednesday, February 29, at 6 p.m.—"Mind and Body." By Dr. E. Mapother, F.R.C.P.

Thursday, March 1, at 6 p.m.—"Vitamins, Their Significance to the Man in the Street." By Dr. Leslie F. Harris, D.Sc.

ROYAL INSTITUTION.

Albemarle Street, London, W.1.

Wednesday, February 29, at 5.15 p.m.—Prof. J. S. Huxley: "The Behaviour of Animals."

Thursday, March 1, at 5.15 p.m.—Prof. F. Ll. Griffith: "Nubia in Antiquity and in the Middle Ages."

Friday, March 2, at 9 p.m.—Sir Farquhar Buzzard: "The Psychology of the Sick."

Saturday, March 3, at 3 p.m.—Mr. Campbell Dodgson: "The Life and Work of Albrecht Dürer."

ROYAL INSTITUTE OF PUBLIC HEALTH.

37, Russell Square, London.

Wednesday, February 29, at 4.30 p.m.—"The Present Legal Aspect of the Treatment of the Insane." By Sir Robert Armstrong-Jones, C.B.E., D.Sc., M.D. (Lond.).

ROYAL SOCIETY OF ARTS.

Monday, February 27, at 8 p.m.—(Cantor Lecture). H. Gough: "Fatigue Phenomena, with special reference to Single Crystals." (Lecture II.)

Tuesday, February 28, at 4.30 p.m.—(Dominions and Colonies Meeting.) Sir Stephen Montagu Burrows, C.I.E.: "The Ancient Civilisation of Ceylon."

Wednesday, February 29, at 8 p.m.—(Ordinary Meeting.) Archibald Crawford, K.C., Director of the Economic League: "Industry Fifty Years Hence." The Right Hon. George N. Barnes, C.H., *will preside.*

SOCIETY OF CHEMICAL INDUSTRY.

Manchester Section, at Milton Hall, Deansgate.—Friday, March 2, at 7.30 p.m.—"Some Industrial Applications of the Potentiometric and Conductrometric Method of Analysis." By T. Cullan, M.Sc., Ph.D., and S. Horobin, B.Sc.

THE ROYAL SOCIETY.

Burlington House, London.

Thursday, March 1, at 4.30 p.m.—A. E. H. Tutton, F.R.S.: "The Hexahydrated Double Sulphates containing Thallium." A. E. H. Tutton, F.R.S.: "The Hexahydrated Double Selenates containing Thallium." W. H. J. Childs: "The Distribution of Intensity in the Band Spectrum of Helium: The Band a λ4650." (Communicated by O. W. Richardson, F.R.S. M. C. Johnson: "Studies in the Behaviour of Hydrogen and Mercury at the Electrode Surfaces of Spectrum Tubes." (Communicated by S. W. J. Smith, F.R.S.)

Papers by the following will be read in title only:—W. E. Curtis, R. G. Lunnon, S. Chapman, F.R.S., N. F. Mott, and G. H. Biggs.

UNIVERSITY COLLEGE.

Gower Street, London.

Monday, February 27, at 2 p.m.—"The Realistic Epic of Castile." A public lecture by Señor A. R. Pastor, Ph.D., B.Litt., King's College, London.

Tuesday, February 28, at 5.30 p.m.—"Henrik Ibsen." First of a course of four public lectures by Prof. J. G. Robertson. Other lectures, March 6, 13 and 20.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

3,240.—Anshinachie, P. P. J.—Manufacture of synthetic ammonia. February 1st.

3,279.—Bennett, N.—Production of aromatic acid chlorides. February 2nd.

3,042.—Goodrich, R. J.—Process of preparing ortho-ortho-dicarboxyl-diphenyl-diamino-anthraqninones. January 31st.

2,864.—*Imperial Chemical Industries,* Ltd.—Production of ethyl alcohol. January 30th.

3,179.—Synthetic Ammonia & Nitrates, Ltd.—Effecting chemical reaction under pressure. February 1st.

Specifications Published.

257,619.—*I. G. Farbenindustrie Akt.-Ges.*—Process for introducing sulphocyanide groups into organic compounds.

263,191.—Chemical Works (formerly Sandoz).—Process for the production of 2-amino-4-nitrophenoxy-ethanol or -propandiol.

284,450.—Wulfing, J. A. Von, and Busch, A.—Processes for preparing neutral to weakly acid water-soluble silicic acid compounds.

284,574.—I. G. Farbenindustrie Akt.-Ges.—*Extraction of carbon dioxide from gaseous mixtures.*

282,049.—I. G. Farbenindustrie Akt.-Ges. Process for producing carbon disulphide.

282,004.—Anthraquinone derivatives. — I. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany.

Abstract Published.

1-(2'-*Carboxyphenyl*)-*anthraquinones* are obtained by oxidation of Bzl : Bz2-benz-benzanthrones or derivatives thereof. According to an example Bzl :Bz2-benz-benzanthrone is oxidised with chromic acid in *glacial acetic acid*. *Bzl : Bz2-benz-2 : 6*-dichlorbenzanthrone and Bzl : Bz2-benz-benzanthrones substituted in the benz-residue are also specified as parent materials.

Bz1 : Bz2-Benz-benzanthrones are obtained by ring-closure with aluminium chloride of benzylidene-anthrones.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

ULTRAVAC.

487,058.—Drying and impregnating machinery and parts thereof in class 6.—Hugh Griffiths, 15, New Bridge Street, London, E.C.4. February 8th.

CELLOSOLVE.

484,787.—Solvents, being chemicals for use in manufactures. — Carbide and Carbon Chemicals Corporation, 30, East Forty-second Street, New York, State of New York, United States of America. February 8th.

BAYKOLICKER.

485,852.—Chemical substances used in manufactures, photography or philosophical research, and anti-corrosives.—I. G. Farbenindustrie Aktiengesellschaft, Mainzerlandstrasse 28, Frankfurt-on-Main, Germany. February 8th.

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CONTENTS. PAGE.

Miller's Experiments and the Constitution of Matter, Part V. 129
Australian Engineer's Account of a Visit to America 130
General Notes:
Building Science Abstracts, New Official Publication 133
Canadian Chemistry Division Report 135
Proceedings & Notices of Societies:—
The Royal Society 136
Geological Society 137
The Physical Society 137
Society of Public Analysts 138
Notices of Books 139
Official and Other Publications 140
Forthcoming Events 142
New Patents 143
New Trade Marks 144

THE PHYSICAL SOCIETY.

The Council of the Physical Society announces that the Thirteenth Guthrie Lecture is to be given by Sir Joseph Thomson, O.M., F.R.S., on "Electrodeless Discharge through Gases." The lecture will be held on Friday, March 9, 1928, at the Imperial College of Science and Technology, South Kensington, commencing at 5 o'clock. No tickets are required.

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MILLER'S EXPERIMENTS AND THE CONSTITUTION OF MATTER. PART V.

By DR. W. TOMBROCK (Holland).

Illingworth, *Physical Review* (Nov., 1927) has repeated Kennedy's work with an even more sensitive apparatus and confirms Kennedy's results (*The Chemical News*, 1927, cxxxiv, 244.

Piccard and Stahel, *Comptes Rendus*, Nov. 28, 1927, in their paper "The Absence of the Ether Wind on the Righi," state that the experiments of Miller were not confirmed, so that Miller stands alone in obtaining a positive result from the Michelson-Morley experiment of 1926. This result has not in the meantime been obtained again by Miller; at any rate it has not been once more publicly confirmed. The discrepancy between observation and theory also still remains unexplained. I have pointed out the confirmation of a part of the conclusions drawn by Miller which has been obtained by observations of an entirely different character (*The Chemical News*, 1927, cxxxv, 1).

Prof. Paul Painlevé lectured on Noevmber 17 at the Institut Français du Royaume-Uni on "Absolu et Relativité." M. Painlevé emphasised the essentially scientific character of the theory of relativity, which has often been falsely represented as a metaphysical doctrine. Relativity demands the objective reality of the external world. What it does is to deprive time and space of the absolute character with which they have previously been wrongly endowed. In M. Painlevé's opinion, the theory is coherent and logically sound.

He also gave an evening discourse at the Royal Institution before a large audience and put the question as to whether matter would appear continuous or discontinuous if our senses were refined far beyond the range of our most powerful instrument—the famous controversy of *plenum versus vacuum*. In turn, continuity and discontinuity have seemed to prevail as an explanation of matter and of light. He then dealt with the atomic microcosm, showing that the study of corpuscular radiations forces us to introduce the idea of discontinuity inside the atom and to regard all matter as made up of two final elements only—the electron and the proton. M. Painlevé mentioned the difficulties which lie in the way of explaining the luminous spectra emitted by atoms, and expressed the hope that the new mechanics, by asso-

ciating material corpuscles with these mysterious waves, would ultimately overcome those difficulties.

These two objections to the special theory of relativity in any case still remain in my opinion :

Tummers : *The two fundamental principles of the theory are contradictory.* His proof thereof has not up to the present been refuted.

Tombrock : *Time is measured duration* and as such is absolute. The relativity of time rests on a confusion of time with motion, which is not absolute but dependent on the attendant circumstances, thus relative.[1]

These two objections have nothing to do with a positive or negative result of Miller's experiments and so do not stand or fall with it.

Finally as concerns the ultimate structure of matter according to my ideas :

Atoms are constituted of protons, the number of which is related to the atomic weight.

Protons are larger material particles with strongly rotary motion.

Electrons are smaller material particles with considerable translatory, less rotary motion; they circulate round and between the protons of the atom, are replaceable by other electrons and ether-particles and can jump from atom to atom and in certain circumstances can be projected from the atom.

Ether-particles are smaller material particles with motions like gas molecules, their *meanspeed greater than that of light, and* can be transmuted into electrons in the atomic mill; *as a result their translatory velocity will in general be smaller, their rotary velocity on the contrary greater.* By this means a *difference* in the ether motion *towards and away from* the atom is produced—gravitation !

Bergen op Zoom, Jan., 1928.

[1] It may appear paradoxical, but *in the measurement of time lies the absolute*, the magnitude of what one measures is *independent of the unit used in the measurement.* The interval between two instants does *not* become smaller if one determines it with a slowly moving clock, hence time is called *absolute.* The neglect of this paradoxical but fundamental truth brings about a confusion of time with the unit of measurement of time; the unit of measurement of time is determined by a special movement and motion is dependent on the attendant circumstances—thus relative. So also is the *unit* of measurement but *not* the interval of time which one measures therewith. The relativity of the time is thus brought about by a confusion of time with motion.

AUSTRALIAN ENGINEER'S ACCOUNT OF A VISIT TO AMERICA.

By R. M. Murray,

General Manager of the Mount Lyell Mining and Railway Company Limited.

(*Presidential Address delivered before the Australasian Institute of Mining and Metallurgy, at Queenstown, Tasmania, on May 26, 1927.*)

Deading with matters other than mining, the following are a few of the more interesting :—

Agriculture, etc.

I travelled through a great deal of agricultural and orchard land, and the most striking feature is the extensive use of irrigation. In fact, cultivation of any sort appears to be rarely undertaken unless irrigation water is available. The fields of alfalfa, cotton, maize, and vast plantations or oranges, walnuts, peaches, and many other fruits, are all on the usual large scale typical of the country.

Railways.

I travelled 10,000 miles on American and Canadian railways. These are almost all owned by private enterprise. The visitor is struck by the large size of the locomotives and rolling stock, and the immense length of the trains, freight trains sometimes being almost a mile in length, and passenger trains being relatively large. The fuel used is either oil or coal, according to the district being traversed, and the service is good, long distance trains running well to time-table. The accommodation, however, is only medium—the Pullman cars seem crude in a country specialising in modern conveniences, and the seating in the day cars is not equal to that in our best Australian trains. In the winter time the artificial heating makes the carriages insufferably hot and close.

Cities.

Even in the relatively smaller cities, such as San Francisco and Los Angeles, one is impressed by the size of the buildings, particularly office buildings and hotels, and by

the traffic; but perhaps most of all by the manner in which they are lighted. The streets at night invariably have a gala appearance, and all important buildings and objects are illuminated. The people take a great pride in their towns, and wish to have them visible at all times. Possibly this feature is a little overdone, but within limits it has everything to recommend it, and could be well adopted in our Australian towns, particularly Melbourne, whose sepulchral gloom at night time is something that none of its citizens can possibly be proud of. New York is truly an extraordinary city, and its buildings, especially in the downtown area, viewed from the top of one of the highest of them, constitute an amazing accumulation of bricks and mortar. Thirty-storey buildings are more the rule than the exception and those of lesser height are regarded as obsolete. The street traffic is extraordinarily dense, and is regulated by semaphores with a master control, but the underground and elevated railways are mostly depended upon for passenger transport. The harbour that surrounds the city on three sides is one of the remarkable features.

PERSONALITY.

The technical men on the works and mines are almost without exception of fine personality, keen and enthusiastic in their work, and anxious to give all information possible. In New York I had the privilege of meeting a number of most interesting men, well known in the mining world, notably Dr. Callow, Mr. Hardinge (Hardinge Mill), Mr. Dwight (Dwight and Lloyd) ,Dr. W. R. Ingles, Mr. Carl Eilers, Dr. Foster Bain (the Secretary of the American Institute), who afforded me every possible facility, and many others, all of whom were men of charming personality and hospitality itself.

INDUSTRIAL.

Work proceeds smoothly and efficiently. Men appreciate that their welfare depends upon output, and wages and conditions are fixed by mutual arrangement between the management and the employees, and seem fairly well standardised from place to place; the 8-hour day is general, and the basic rate is usually about 16s. or 17s. Works do not suffer from a multiplicity of classifications and demarcations of jogs, all the operating men employed in a concentrating mill, for instance, being on the same classification, which makes for economy and efficiency. At the Trail works there have been no industrial unions since a big strike which took place several years ago, and industrial differences and other matters are adjusted by a council comprising representatives of employer and employees. In Now York I had an interesting experience as to strikes in that part of the world, as shortly after I arrived there the whole of the employees of the underground and overhead city railways went out. With this means of transport out of commission New York must cease to function, and the carrying on of the service is absolutely a vital matter. Immediately upon the commencement of the strike a volunteer staff was able to maintain a 50 per cent. service, and on the following day a 75 per cent. service was organised and maintained, this gradually increasing until in three weeks' time the strike broke down. The features that most interested me were the prohibition of picketing, which is absolutely illegal in any shape or form, and the fact that the settlement included the retaining of the services of all volunteers who wished to remain.

In considering the circumstances and conditions under which the mining industry exists in America, as compared with Australia, the advantages that A merica possesses are outstanding, the most important being the following :—

1.—The huge scale of operations reduces overhead costs to a minimum and permits large expenditure of capital on new plant, etc., without disproportion of depreciation charges, and it also affords wonderful opportunities for research work on a plant scale, some companies running pilot mills for experimental work, which are as large as the whole treatment plant in many instances in this country.

2.—The enormous home market for products and ready access to foreign markets.

3.—The accessibility of the latest machinery and plant and general supplies at a minimum cost.

4.—The cheapness of power and fuel.

5.—The freedom from burdensome industrial conditions, restrictions of output, etc.

As compared with the foregoing, Australia has the following handicaps :—

1.—Mining operations are on a comparatively insignificant scale, except possibly in the case of Broken Hill, which means high costs and renders research work on a plant scale impracticable, and comparatively

small additions and alterations to plant involve a cost bearing a high ratio to the total capital invested.

2.—Markets for products are on the other side of the world.

3.—The latest machinery and plant is not available for inspection, and if purchased can only be imported at extortionate cost, due to freight and high tariff.

4.—Except in favoured places, power and fuel are very expensive, the cost of coal and coke being extraordinarily high, considering the many splendid coalfields available, and fuel oil, so desirable in many metallurgical processes, is almost out of the question.

5.—Industrial conditions brought about by Arbitration Courts and similar tribunals and by special legislation, have enormously increased the cost of labour, plant, and supplies, and have reduced efficiency.

Concerning the effect of the tariff on the cost of plant, a certain machine may be made on a large scale in an American factory and could not be commercially attempted in an Australian engineering shop, even if the equipment of the shop were suitable to undertake its manufacture, as it would probably be the only one of its kind required in the country, yet duty as high as 60 per cent. is charged. So long as some manufacturer will undertake to make something that will do work of the nature of that performed by the apparatus required, the up-to-date article must be excluded in order to protect the obsolete one.

With regard to the position brought about by the arbitration courts, etc., after experience with these tribunals from their inception, I am satisfied that they are a tragic failure. In the first place, they actually manufacture and encourage so-called disputes in so far as the refusal of an employer to concede the demands contained in a log served upon him, however extravagant these may be, constitutes a dispute between him and his employees. In the Federal Court such a refusal happening in each of two States constitutes an interstate dispute, though the men employed by the respective employers and the employees themselves may never previously have heard of one another, and may have nothing in common. In the second place, courts actually encourage strikes instead of preventing them, as we have not infrequently seen instances of organisations going on strike in order to have their cases heard immediately instead of waiting their turn on the list. In addition, the Court proceedings antagonise employer and employee and destroy the mutual confidence that should obtain between them. They have taken the control of industrial affairs out of the hands of experts (both employers and employees), and placed it in those of men who, however conscientious and keen to do the right thing by all concerned, are necessarily amateurs as regards the technical questions they are required to adjudicate upon. Further, they have, no doubt, quite unwittingly caused work to be regarded as a bogey and something to be shunned.

The Navigation Act has added to the troubles of industry, and made transport both uncertain and costly; freight between Australian ports being often higher than between those ports and Great Britain, and the precarious state of shipping is accentuated by the high cost and uncertainty of waterside labour, and of coal supply, largely due to the interference of courts and tribunals.

The condition of the Australian mining industry to-day is largely due to the disabilities enumerated, and other industries are finding themselves in a similar plight. Although I wish to give great stress and importance to these disabilities, I do not wish to give the impression that I underrate my native country. After a journey round the world, I returned to Australia with the conviction that it is the best country of all, with its wonderful advantages of climate, natural productiveness, purity of race, and the opportunities it affords to everyone who chooses to take full advantage of them. I do feel, however, that the way we are managing this great continent of ours is not beyond criticism, and that we are earning for ourselves an unenviable reputation from people overseas both in the Old World and the New. There is too great a tendency on the part of public men to declaim our greatness and how we lead the van of progress, etc., without any real understanding of the true position. We do not lead the van save probably in the great primary industry of woolgrowing, and unless we realise the facts we will gradually become a pastoral and agricultural country purely and simply. We have indulged in expensive and illusive experiments with national affairs long enough, and not until this is realised and we get down to solid business will we develop into the great nation that Nature has so abundantly provided for, and in whose activities the mining industry should play by no means the least important part.

GENERAL NOTES.

BUILDING SCIENCE ABSTRACTS.

A new monthly publication of interest to all concerned in building construction and allied subjects has been placed on sale by H.M. Stationery Office. Its purpose is to provide, for the Building Industry, up-to-date summaries of the latest developments in the science and practice of building which are taking place throughout the world. Such a service is already provided for the members of other professions by periodicals such as "*Biological Abstracts*" and "*Chemical Abstracts*," and the Department of Scientific and Industrial Research has now decided to prepare for general circulation "*Building Science Abstracts*." This has become possible partly as a result of generous support promised by the Institute of Builders.

In this periodical all the more important articles appearing all over the world relating to building will be abstracted by the staff of the Building Research Station at Watford. The enormous literature on the subject and the degree of scientific specialisation which is now essential, make it extremely difficult for any single worker to keep abreast of the whole subject. Only by a scheme of co-operation such as that which the new abstracts will provide can the individual ensure that he misses nothing on the subject in which he may be interested. Some idea of the wealth of printed matter dealing with the building and constructional industries can be gathered from the fact that over 100 different scientific and technical periodicals are being drawn upon regularly in the preparation of the Abstracts.

The Abstracts are classified under the following headings:— Stone, mineral earths, clay and ceramics; Lime, plaster, and chemical compositions in general; Cement and concrete; Metal; Organic building materials; Paint and varnish; Materials in general, their properties and testing; Elements of structures; Housing and domestic engineering; Specialised construction.

Within these groups will be found abstracts of papers primarily of interest to the Building Industry, the teachers of building science and the manufacturers of building materials, while at the end of each section are grouped abstracts of interest chiefly to research workers. These are followed by references to books and patents.

Publication will be monthly except in August, but a double number (August-September) will appear at the end of September. Subject and name indexes will be issued annually.

The subscription rate for the series of eleven monthly issues (including one double number) has been fixed at 10s., post free. Single copies are available, price 9d. each (post free, 10d.).

SMOKELESS FUEL.

FAMOUS ENGINEER'S CLIAM.

"There is no longer any need for the Government and local authorities to speculate as to when, if ever, a smokeless fuel is going to be produced. It is being produced now on a commercial scale, and at a most satisfactory profit."

This claim in regard to the progress of low-temperature carbonisation of coal was made by Lt.-Col. W. A. Bristow, the well-known consulting engineer, in the course of a paper read at Birmingham, on Friday, February 24, at the Carbonisation Conference, organised by the oint Fuel Committee of the Society of Chemical Industry, the Institution of Gas Engineers, the Coke Oven Managers' Association and the Institute of Fuel.

Colonel Bristow said that the system employed by Low-Temperature Carbonisation had been proved economical under large scale conditions, and the works at Barugh at the present time were carbonising 1,500 tons of coal a week, yielding over 1,000 tons of coalite (the residual smokeless fuel), 28,200 gallons of oil, 8,750 gallons of benzole, and 7,000,000 cubic feet of rich gas.

TAR OILS SOLD FOR MONTHS AHEAD.

Instancing the commercial progress of the scheme, Col. Bristow said :—

"The tar oils are sold for months ahead to refineries in this country, and buyers on the Continent have also made satisfactory offers for large quantities. The prices are higher than those obtained for gas-works tar oils, and the value of the oil obtained from one ton of coal is greater than the cost of the coal. In addition, each ton of coal produces about 14 cwt. of smokeless fuel, which sells readily at prices equal to those paid for best house coal. There is also a profit to be made on the gas, which has a calorific value of about 700 B.Th.U per cubic foot. In the opinion of the Fuel Research Board, it ought to pay any gas company to take this gas at 2d. to 2½d. per therm."

The coalite, said Colonel Bristow, was dropped from the retort in size and condition ready for burning in any type of grate, open or closed. In powdered form, it made the best possible pulverised fuel, owing to its high carbon content, dryness, fluidity, through the burners, and smokelessness; and it was not liable to spontaneous ignition when stored. It was also very suitable for gas producers and a number of small incidental applications like smithy work and steam road wagons.

The tar oils contained crude naphtha, carbolic oils, creosote oils, anthracene oils, and soft pitch. The finished products comprised refined motor spirit, rubber solvent, cresylic acid, gas wash-oil, fuel oil, lubricants, and other subsidiary products.

CANADIAN TALC AND SOAPSTONE INDUSTRY SHOWS PROGRESS.

The production of talc and soapstone in Canada in 1926 totalled 15,767 tons, valued at $217,195. These figures represent an increase of 1,293 tons and $11,360 over 1925. The first six months of 1927 show a slight decline of 159 tons and $3,707 over the corresponding period of 1926.

The bulk of the ground talc produced in Canada continues to come from the Madoc district, Hastings County, Ontario, where important deposits of superfine, foliated, white talc have been worked for over twenty years.

SMOKELESS FIRES THAT LAST.

In view of the claim that low temperature carbonisation of coal is now a commercial proposition, practical comparative tests of the capacity of coalite, the residual smokeless fuel of this process, have been carried out by Messrs. T. & H. Roscoe, of Stockport, fuel experts.

The results show that low-temperature fuel in a closed stove lasts longer and makes less waste than anthracite or best quality gas coke. The weight of fuel used in each case was 14 lbs., and the results were :—

	L.T. Fuel	Anthracite	Gas Coke
Hours burning	27¾	11½	7½
Unburnt fuel ...	6 oz.	13 oz.	19 oz.
Residue (Cinders)	Nil	42 oz	Nil.
(Ash) ...	18 oz.	32 oz.	26 oz.

GAS HEATING AT TWO EXHIBITIONS.

Thirty "St. Martin" gas-heated radiators, manufactured by Messrs. John Wright & Co. (one of the constituent firms of Radiation, Ltd.) at their Essex Works, Aston, Birmingham, were installed in the Holland Park Hall of the Business Efficiency Exhibition. At the British Industries Fair, held simultaneously, all the heating and cooking, apart from the special appliances at exhibitors 'stands, were also carried out by gas.

IRISH FREE STATE TRADE.

Imports in 1927 were slightly smaller than in 1926, while exports were nearly 3 million pounds larger. The bulk of the trade was with Great Britain, Northern Ireland, the United States and Germany.

MARKED INCREASE IN PETROLEUM AND NATURAL GAS PRODUCTION IN WESTERN CANADA.

According to a statement issued by the Department of the Interior at Ottawa, steady progress in the development of the petroleum and natural gas resources of Western Canada has been made during 1927.

There was a marked increase in the gas and oil production of the western fields, the output of oil reaching 329,000 barrels, while the production of gas for consumption totalled nearly eleven and a half billion cubic feet. The 1926 figures for oil were 219,000 barrels and for gas nine and a half billion cubic feet.

GERMAN FOREIGN TRADE.

German imports in December last exceeded exports by 304.3 million marks as against an excess of the former over the latter of 377.2 million marks in November. Imports (excluding gold and silver) declined 33 million marks, as compared with November, while exports advanced by 43 million marks.

CZECHOSLOVAK TRADE.

The trade balance during December last was against Czechoslovakia to the extent of 84,940,000 crowns, whereas for the whole of 1927 a favourable balance was recorded amounting to 2,197,176,000 crowns.

SOUTH AFRICAN TRADE IN JANUARY.

The Standard Bank of South Africa reports the receipt of a cablegram from their general managers intimating that during the month of January imports into the Union of South Africa were valued at approximately £6,119,842, and exports from the Union at about £6,888,889, the latter including £2,957,389 native gold.

ALUMINIUM.

An outstanding feature of the Canadian mining report is that exports of aluminium in 1927 were more than double those of the previous year. For the calendar year 1927, the reports shows exports of aluminium in blocks, etc., as 51,902,400 pounds, valued at $5,900,547 in 1926. This metal now ranks fifth in value in the exports of Canadian non-ferrous ores and smelter products.

CANADA—CHEMISTRY DIVISION REPORT, 1927.

F. G. Wait, Chief of Division, reports :

From April 1, 1926, to March 31, 1927, twelve hundred specimens have been reported on.

The work of the different members of the chemical staff has been as follows :

H. A. Leverin concluded his investigation on titanium pigment and submitted a final report thereon. In addition, he examined mineral specimens and made a number of analyses of alloys, abrasives, limestones, etc.

R. T. Elworthy completed his report on helium and natural gas. He investigated the actions of acids on bituminous sands and the preparation of pure methane from natural gas, also the oxidation of natural gas. From September he was on special leave.

E. A. Thompson has made complete analyses of three specimens of greywacke and one other rock for the officers of the Geological Survey, also a sample of gypsum.

Three samples of saline water were analysed and the determination of lithium and fluorine in a specimen of lepidolite, also a complete analysis of two samples of Allenby mine tailings and concentrates.

Microscopic examinations were made of Allenby mine ore and tailings; Gold Hill ore from Boston Creek; Ivry ilmenite ore, also sponge and residue after treatment of the ilmenite ore for the making of electrolytic iron; titanium paint pigment and accessory materials; also stream line wire, for Royal Air Board. Microphotographs were made in each case.

Metallographic examination of twenty specimens of electrolytic iron was made, also microphotographs.

James Moran was engaged chiefly in the work of mine air analyses. Two hundred and seventy-two samples were analysed during the year, a number of them calling for special work in determining the nature of the air following blasting operations, mine fires, and feeder gas, etc.

Included in this work also, were the preparation of memoranda for the guidance of mine operators and inspectors, and special reports covering mines where fatal accidents occurred.

A. Sadler made a large number of furnace assays and analyses, complete and partial, of ores and minerals.

He has also examined several earths and clays as to their suitability as decolourising agents for oils and fats. The object in view was to find a Canadian substitute for imported fuller's earth and other like media.

Considerable tests were run on bentonite, but these in their natural state were found to be comparatively poor decolourisers of oils; nevertheless it was discovered that in the presence of other reagents very satisfactory results were obtained.

G. P. Connell was loaned to the Fuel Testing Division where he has been employed for the year.

TRADE CATALOGUES.

Baird and Tatlock (London) Ltd.

This well-known firm of Cross Street, Hatton Garden, London, issues a large, profusely illustrated and handsomely bound catalogue, of the "Where is It" style. Some idea of its magnitude and completeness will be inferred from the fact that it extends to over 1,100 4to pages. Among the departments, are Laboratory and General Equipment, Chemical Apparatus, Physical Chemistry, Industrial Chemistry, Meteorology, Scientific Books, and Pure Chemical Standard Solutions.

F. Weinreb.

16, and 17, Devonshire Square, London, E.C.2., representative for Great Britain and the Colonies of Kühne, Kopp and Kausch, of Frankenthal-Pfalz, Germany, whose Chemical and other Machinery has a good reputation for high-class manufacture, efficiency and durability. Special reference is due to the homogeneous lead lined machines, the lead lining conducing to efficiency, durability and economy, three most important characteristics in this progressive and competitive age. A practical demonstration of the utility of this lead lined machinery is shewn by the long list of high-class British firms in London and throughout Great Britain and also in other countries, who have been supplied with this machinery. Among these firms we notice such world-famed names as Lever Brothers, Vickers, Ltd., British Dyestuffs Corporation, Ltd., Nobel's Explosives Coy., Ltd.

Reavell and Company, Ltd, Ipswich.

We learn that this firm (who are contractors for the Admiralty, etc.) have acquired the sole British Empire rights for the manufacture of the Reavell-Askania Regulating Apparatus, for which it is claimed that its use will lead to lower operating costs of fuel, etc.; a more uniform product of higher quality; reduced labour charges; more consistent and reliable operation; and hence, increased output, and an overall saving which will pay for the apparatus in a very short period.

Murphy & Son., Ltd., The Laboratories, Sheen Lane, London, and also at Leeds and Nottingham.

The present is Bulletin Nos. 15 and 16, dealing scientifically with: The Absorption of Odours by Beer; An Old Recipe for Sweetening Casks; An Experimental Brewing Plant; An Unusual Growth-form of *Monilia Candida;* The Giant Wood-Wasp in a Fermenting Vessel; Notes for Growers; Insect *versus* Power; Little Drops of Water; Carbolineum Washes for Winter Spraying. The various articles have been written by experts and are appropriately illustrated. We notice, by the way, that the first model brewery plant ever constructed by brewery engineers for a private laboratory in this country was erected for Mr. A. J. Murphy (present managing director of the firm) in his Leeds laboratory about thirty years ago, so that the firm is old-established and favourably known in chemical, general scientific and engineering circles.

We might add that the price of the Bulletin is 8s. net., or, annual subscription of 7s. 6d.

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.

The following papers were read at the meeting held on Thursday, February 2:—

Studies in the Microchemistry of the Cell: I. By R. J. Ludford. Communicated by J. A. Murray, F.R.S.

According to Feulgen, when sections of suitably fixed material are submitted to mild hydrolysis, treated with fuchsin-sulphurous acid, and thoroughly washed in sulphurous acid, the nucleo-proteids of cells are stained an intense purple or violet colour. This reaction has been carried out with various animal tissues (ovarian, testicular, glandular, etc.). In each case nothing but chromatin was stained in the cells.

In sections through a tar tumour and surrounding skin, no difference was apparent in amount of chromatin of normal and malignant cells. It was not found possible to correlate any relationship between amount of chromatin in tumour-cell nucleus and rate of growth of tumour.

Large nuclei often contain approximately same amount of chromatin as do small, but the giant nuclei which occur in some tumours, and are apparently formed by fusion of smaller nuclei, contain large masses of chromatin.

Cytological Studies on the Viruses of Fowl-Pox and Vaccinia. By R. J. Ludford. Communicated by J. A. Murray, F.R.S.

Virus bodies produced by vaccinia on skin of chick are exactly the same as those of fowl-pox, in structure, in origin and in development.

Vaccinia virus produces in epidermal cells of rat's cornea inclusions closely resembling those of the chick, but differing fundamentally in absence of covering osmophil substance, characteristic of virus bodies of chick. In cells surrounding centre of lesion, clusters of granules (Schult's granules) are formed, the result of infection of cells of regenerating epidermis.

Vaccinia virus can be transmitted from rat's cornea to skin of chick, where it results in formation of characteristic virus bodies. Chick virus does *not* bring about same result in epidemal cells of rat cornea.

One strain of fowl-pox was found to produce in epidermal cells of pigeon the same type of virus bodies as in chick, but was without action on epidermal cells of

rat cornea. The origin and development of the various virus bodies, and their relation to cell organs, are described.

GEOLOGICAL SOCIETY.

The following communication was read :--

'*The Geology of the District around Dinas Mawddwy (Merioneth).*' By PROF. WILLIAM JOHN PUGH, O.B.E., B.A., F.G.S.

The Dinas Mawddwy area includes about 22 square miles of country in South-Eastern Merioneth. It forms part of the Central Wales Plateau, and is dissected by deep valleys, somewhat modified by glacial action.

The rocks consist of mudstones, shales, and slates, with subordinate bands of grit and limestone. They belong to the Bala and the Valentian Series. The succession is similar to that in the adjacent area around Corris,[1] and the same classification has been retained. There are, however, certain lateral changes within the Bala Series, both in lithology and in fauna.

The Upper Ceiswyn Beds change in a north-easterly direction from barren, grey-blue, slaty mudstones, into rusty-weathering calcareous mudstones, which yield *Trinucleus caractiaci*, *Dalmanella* cf. *testudinaria* var. *shallockensis*, *Cliftonia spiriferoides*, *Asaphus powisi*, etc.

The black graptolitic shales of the Nod Glas persist throughout the area; but north of Dinas Mawddwy then include thin, dark, argillaceous limestone-bands, which yield in fair abundance *Plectambonites sericea* cf. var. *thraivensis* and *P.* cf. *papillosa*. These calcareous bands are recorded on the Geological Survey map as the Bala Limestone.

The Garnedd-wen Beds change from a massive sandy mudstone-group in the west, to a mainly fine-grained shale series in the east. *Phacops mucronatus* occurs in the mudstones which intervene between the Narrow Vein and these rusty-weathering shales. The latter are apparently devoid of fossils.

The succession is compared, so far as possible, with those of Plynlimon, Bala, and the South-Western Berwyn Hills.

The Dinas Mawddwy country is located on the south-eastern flank of the Harlech Dome, and the fact that the rocks are folded around that great anticline determines the general direction of the strike, which is from south-west to north-east; but the region has been folded along north-and-south axes, and some of these folds are correlated with important structures farther south in Central Wales, as, for example, the Teify Anticline, etc.

THE PHYSICAL SOCIETY.

Friday, January 27, 1928, at the Imperial College of Science.

Prof. O. W. Richardson, M.A., D.Sc., F.R.S., and subsequently F. E. Smith, D.Sc., F.R.S., in the chair.

The Swan Band Spectrum of Carbon. By W. E. PRETTY, A.R.C.S., B.Sc.

The Swan spectrum has been obtained in carbon monoxide and in the carbon spark in the absence of hydrogen. A discussion of the results of experiment and theory leads to the conclusion that the emitter of the Swan band system is the molecule of carbon C_2.

DISCUSSION.

Dr. R. C. Johnson said that, while the author's work was of great interest, he did not think that it justified the conclusion reached. The emissions of the Swan band from carbon monoxide dried with P_2O_5 was a familiar occurrence; but he did not think that the absence of hydrogen could be assumed. The relative intensity of spectra depends more on the excitation potentials than on the percentage in which the components of a gas mixture are present. Thus a mere trace of a hydrocarbon in helium at a pressure of 40 mm. will drown the helium spectrum, owing to the relatively low excitation potential of the former. Mulliken, in the *Physical Review*, had recently pointed out that the molecules C_2, BN, BeO, LiF all have a similar outer structure; they are polar molecules of marked chemical stability, and are theoretically incapable of emitting band spectra, while extensive experimental research has hitherto
F.I.C.
failed to reveal band spectra in any of these cases, with the doubtful exception of BeO. Analogy, therefore, makes the C_2 origin of the Swan bands improbable, whereas the C_2H_2 molecule is similar in its external structure to N_2, which has two valency electrons and exhibits a band spectrum similar to the Swan spectrum. Again, if a gas jet be plentifully supplied with air the flame is blue, owing to the presence of 4315 band of C_2H_2, whereas when the air supply is re-

duced the Swan spectrum appears and turns the flame green; this result may be *attributed to the association of 2CH into* C_2H_2, which may be regarded as a rotating dipole HC-CH. Shea had suggested $(C^-)_2$ as the Swan emitter, but there appeared to be no justification for the revolutionary assumptions involved in this suggestion, and such a structure, if it could exist, would not resemble the N_2 molecule. It was desirable to investigate the Swan absorption spectrum. Hori had obtained it by exploding by sudden heat a thread of mercury in a vacuum chamber which happened to contain hydrocarbon gases from the oil of a pump. It would be interesting to fuse the filament of a carbon-filament lamp, after exhausting the latter if necessary, and to see whether the absorption spectrum was obtained.

Prof. E. N. da C. Andrade pointed out that hydrogen would be occluded in the carbon of the lamp, and the speaker agreed that the result would be inconclusive.

Dr. W. Jevons : An experimental investigation as to the emitter of the Swan band system was perhaps one of the most urgent in molecular spectroscopy, and I tender my *hearty congratulations to the author on the* very thorough manner in which he has carried it out. His result will, I am sure, win immediate and general acceptance. It is unfortunate that Mr. Pretty's Paper did not appear ,say, two months ago, for a very important paper (*Phys. Rev.*, 30, 825, December, 1927) has just been published by J. D. Shea, who has analysed the 0,0 (λ5165), 0,1 (λ5635), 1,0 (λ4737) 1,1 (λ5129), and 1,2 (λ5585) bands, and, like Mr. Pretty, has pronounced in favour of C_2 as the emitter, but has added a suggestion that it might be $(C^-)_2$. *In a preliminary* report of this work to the American Physical Society (*Phys. Rev.*, 27, 245, abs. 14, 1926)Shea and Birge drew attention to the surprising similarity of the values obtained for the moments of inertia (I_0) and the electrionic angular momentum (ϵ) of the emitters of the Swan system and the N_2 "Second Positive" system. And, since the acetylene molecule $(CH)_2$ has the same number of electrons and nearly the same mass as N_2, they thought that $(CH)_2$ *might* be the Swan emitter if it could vibrate and rotate as a dipole. The $(CH)_2$ *suggestion, though* supported in Dr. Johnson's paper (which appeared shortly afterwards), was not acceptable to several practical spectroscopists who had had very many years' experience as to the occurrence of the Swan bands, nor to the investigators who have done most to bring about the rapid development of the theory in the last twelve months. On the face of it, a tetra-atomic molecule like $(CH)_2$ was unlikely to emit a band-system of the same simplicity as one emitted by the di-atomic molecule N_2. Mulliken has, as Mr. Pretty states, attributed the Swan bands to the transition ${}^3P \rightarrow {}^3P$ (or, less probably, ${}^3D \rightarrow {}^3D$) in the C_2 molecule; and I might add that Prof. Mulliken informed me last summer that Hund had deduced that the Swan emitter has, like He_2, etc., zero nuclear spin—a result compatible with a pole like C, but not with one like CH. Shea and the author of the present paper are, then, in agreement with Hund and Mulliken. Like Dr. Johnson, I have a difficulty in understatnding why the Ne-like (no-valence-electron) molecule C_2 should emit a band-system of the same type as one emitted by Mg-like (two-valence-electron) molecule N_2. Shea's $(C^-)_2$ would remove the difficulty, *if* it could reasonably be assumed to exist in an electronically excited ${}^3P$ state, and also to be capable of vibration and rotation as a dipole. I would like to add a word about the other two twelve-electron molecules BN and BeO, which Dr. Johnson mentions with C_2 as being improbable emitters.

SOCIETY OF PUBLIC ANALYSTS

The following papers were read at the meeting held on January 11 :—

Determination of Small Quantities of Benzoic Acid and Cinnamic Acid, with Some Notes on the Colorimetric Determination of Salicylic Acid. By J. R. Nicholls, B.Sc., F.I.C.

A colorimetric method of determining benzoic acid is based on its partial oxidation, in a constant proportion, to salicylic acid by means of hydrogen peroxide in the presence of ferric chloride, and colorimetric determination of the salicylic acid under specified conditions. Cinnamic acid may be determined by first oxidising it quantitatively to benzoic acid.

Report of the Preservatives Determination Committee of the Chemists of the Manufacturing Confectioners' Alliance and of the Food Manufacturers' Federation, on the Determination of Sulphur Dioxide in Foods. By L. E. Campbell, M.Sc., F.I.C.

A normal procedure and an apparatus for the determination of sulphur dioxide in foods have been devised, and details of

standard volumetric and gravimetric determinations are given, together with details of the treatment required in certain special cases, such as starch, gelatin, meats, dried fruits, etc.

Notes on the Effect of other Reducing Substances on the Determination of SO_2. By J.W. Black, B.Sc., A.I.C., and B. J. Warren, F.I.C.

In some cases (*e.g.*, glucose and gelatin, the interference of other reducing substances is negligible, but in others (nutmeg, mustard, ginger, etc.) it is considerable, and a time limit must therefore be set to the distillation period. The behaviour of different substances was shown by means of curves.

Rapid Estimations of Sulphites by Alkaline Liberation, or Extraction, and Titration. By H. R. Jensen, M.Sc., F.I.C.

The sulphite content of certain products such as glucose syrup and cornflour may be satisfactorily determined by direct extraction followed by titration with iodine. Details of the procedure were given.

Barium Sulphate Losses in Gravimetric Estimations. By H. R. Jensen, M.Sc.,

A series of tests was made to determine the amount of loss within the optimum range of acidity for the precipitation of barium sulphate. Too low acid concentration favours adsorption of barium chloride; hence it is desirable to all the reagent in a very fine jet, and to have an excess to reduce the solubility of barium sulphate and the adsorption of alkaline sulphate.

Determination of Sulphur Dioxide in Sausages. By Osman Jones, F.I.C.

On the addition of sulphite to sausages there is an immediate loss of sulphur dioxide, so that the amount found is invariably lower than that added. The best conditions for the determination of sulphur dioxide are given. A method of vacuum distillation is described, and is shown to give results agreeing well with those of the Committee's standard method.

Note on the Oxidation of Sulphites by Air. By H. M. Mason, M.Sc., F.I.C., and G. Walsh.

Carbon dioxide must be quite free from oxygen if used in a lengthy sulphite distillation. Removal of the adsorbed air from the foodstuff by the use of a vacuum before the heating will prevent oxidation losses, but good results are also obtained by extremely rapid heating and distillation.

Note on the Titration of Dilute Sulphite Solutions with Standard Iodine Solutions. By H. M. Mason, M.Sc., F.I.C.

It is shown that the low results obtained when sulphite solutions are titrated with iodine are due to oxidation and to the escape of sulphur dioxide set free by the hydriodic acid formed during the titration, the latter being responsible for 70 per cent. of the loss.

Determination of Sulphur Dioxide in Fatty Substances. By A. W. Knapp, B.Sc., F.I.C., and R. J. Phillips, F.I.C.

The influence of fats (fresh and rancid) on the volumetric determination of SO_2 is dealt with. In rancid fats free from sulphur dioxide volumetric determinations show an apparent content of SO_2. Hence, only the gravimetric process should be used in such cases.

NOTICES OF BOOKS.

General Science, Mainly Chemistry and Biological. By E. J. Holmyard, M.A., M.Sc., F.I.C. (Head of the Science Department, Clifton College, Senior Matriculation Examiner in Chemistry, University of London, etc., etc.). Pp. xiv + 286. Price 4s. London: J. M. Dent & Sons, Ltd.

Mr. Holmyard is an expert on the branches of science dealt with by the present admirable treatise. It is clear and compact; it is not over-weighted with unnecessary details; it places before the student exactly the knowledge which will, if he has the necessary aptitude and perseverance, meet the examiner with confidence. The work has another quality which will recommend it to many students: it is remarkably cheap, while containing essential instruction, and so is within the reach of a number of students who cannot afford the larger, more pretentious and more expensive works, which would be less suitable for many than the compact and admirably arranged book now before us.

The Rate of Living, Being an Account of Some Experimental Studies on the Biology of Life Duration. By Raymond Pearl, Director of the Institute of Biological Research in the Johns Hopkins University, U.S.A. Pp. 186, with 36 illustrations. Price 10s. 6d. net. The University of London Press, Ltd., Warwick Lane, London, E.C.4.

Professor Pearl is so well known as a writer on biology and kindred subjects that

one is never disappointed in any of his works. Accuracy, the outcome of extensive research is a characteristic feature of his works. He is of course fortunately placed in having at his disposal material obtained both by himself and the many other persons engaged in research work, both in the Johns Hopkins University and elsewhere. In the present instance the author is led by a series of experiments to the conclusion that the length of life depends inversely on the rate of living. The study in the present work has been devoted to the habits and life of other forms of life than that of human beings. Numerous life tables are given in the appendices to the book.

Commonwealth of Australia. First Annual Report of the Council for Scientific and Industrial Research (from 13 April, 1926, to 30 June, 1927).

The Council was reorganised during 1926 by the Commonwealth Government. Three members of the Council are nominated by the Government (one being chairman), the chairman of each State Committee of the Council, and other members co-opted by reason of their scientific knowledge. The Committee has pretty wide powers, and by the Act dealing with the matter, a sum of £250,000 was provided for to enable the Council to carry out its objects. Naturally a good deal of preliminary work was necessary before any tangible results could be shewn, but already the Council has given evidence of its vitality and its ability to grapple with and elucidate the many difficult problems listed on its programme. At the early meetings it was decided to concentrate attention on the following important group of problems :—

1. Animal pests and diseases.
2. Plant pests and diseases.
3. Fuel problems, especially liquid fuels.
4. Preservation of foodstuffs, especially cold storage.
5. Forest products.

Extensive investigation on Tobacco is being carried out, and especially to ascertain whether leaf can be produced in Australia equal in quality to that grown in North America. The irrigation problem, which is one of the most vital to many parts of the Commonwealth, is being considered. The Council has started with the hearty good wishes of all interested parties and is receiving the necessary co-operation of those connected with the various industries, and judged by the first report, its labours will prove of untold value to the Commonwealth.

RECENT U.S.A. OFFICIAL PUBLICATIONS TO HAND.

Bureau of Standards.

Thermal Expansion of Beryllium and Aluminium.

Beryllium Alloys.

The Manufacture of Lime.

Practical Application of the Earth-Current Meter.

Annual Report of Director of the Bureau of Standards to June, 1927.

Fifteenth Annual Report of the Secretary of Commerce.

An Analysis of the Arc and Spar Spectra of Scandium, Sc I.

A Modified Method for Determination of the Copper Number of Paper.

Some Vulcanisation Tests of Guayule Rubber.

Master Specification for Boots, Rubber, Short, Heavy.

A Study of Problems Relating to the Maintenance of Interior Marble.

Master Specification for Leather, Bag.

Master Specification for Brick, Sandlime Common.

Quality of the Surface Water of New Jersey.

Brown Iron Ores of West Middle Tennessee.

Quicksilver Deposits of the Pilot Mountains, Mineral Country, Nevada.

The Gillette Coalfield, Northern Wyoming.

The Scaphites, An Upper Cretacious Ammonite Group.

Cephalopods from the Lower Part of the Cody Shale of Oregon Basin, Wyoming.

The Cephalopods of the Eagle Sandstone and Related Formations in the Western Interior of the United States.

Laboratory Tests on Physical Properties of Water-bearing Materials.

The Gilbert District of Nevada.

Annual Report of the Director of the Geological Survey.

Upper Triassic Marine Invertabrate Faunas of North America.

The U.S. Geological Survey, Bureau of Standards, and other Departments, continue to issue many important documents. The Annual Report of the Director of the Geological Survey, George Otis Smith, refers to the general work of the survey. Every project is planned to be productive, but much of the work is necessarily fundamental and, although regarded as absolutely essential, is not expected to yield immediate results. The insistent demand by

engineers for reprints of some Geological Survey reports many years out of stock is a practical measure of the continuing value of investigations long since made. Scientific fact finding, whether its product is a topographic map or a table of stream discharge, or a geologic description, is a piece of productive work, possessing both immediate and future value. Expenditures for such work constitute an economic investment.

To reach the public with the facts is an essential part of Government research. The Geological Survey secures prompt and wide publication of the results of its scientific work.

Bulletin 796A, by C. E. Dobbin and V. H. Barnett (35 c.) deals with the Gillette Coalfield in N.E. Wyoming, and has a chapter on the Mintern district by W. T. Thom.

Bulletin 795F (5 c.), The Gilbert District of Nevada, is by H. G. Ferguson. The quality of the surface waters of New Jersey is dealt with in Water Supply paper 596E by W. D. Collins and C .S. Howard.

Bulletin 795D, by E. F. Burchard, deals with the Brown Iron Ores of West-Middle Tennessee; 795E is by W .F. Foshag and covers the Mercury deposits of the Pilot Mountains in Nevada.

In the Fiftieth Annual Report of the Department of Commerce (30 c.), the Secretary reviews the general economic situation.

The year continued the economic progress which has now been characteristic of American Industry for six years. It exceeded all previous records in volume of production and consumption, and in the physical quantity of exports and imports. There was very little unemployment, except during a moderate recession near the end of the year, and the rate of real wages remained higher than anywhere else in the world or than at any other time in world history. The high prosperity of the year did not represent merely an upward swing in the business cycle but was the result of that general and permanent progress the extent and causes of which are more fully set forth in other sections of the report. There were, to be sure, a few aspects of American business which were less satisfactory, as, for example, the coal and textile industries, the relatively low price of cotton with its depressing effect upon the farmers of large regions of the South, and some continued depression in agriculture of the mid-West, although improvement is taking place since the fiscal year in both sections.

On the whole the level of wholesale prices has been very steady during the past five fiscal years. There have been no sharp upward price movements due toboom psychology and no sudden drops due to contraction in demand. The average wholesale price index for 1926-27 was 6 per cent. lower than that for 1925-26.

The Annual Report of the Director of the Bureau of Standards (10 c.), deals with the many activities of this bureau during the year.

Most of the bureau's work is made effective through voluntary co-operation of the State and municipal governments, scientific and professional societies, trade associations, manufacturers, and individuals who accept the findings of the bureau and incorporate them into a State law, a municipal ordinance, a dimensional standard, or a standard of quality, performance, or practice.

All such co-operation is encouraged to promote a better understanding between producer and consumer and between industries, to the end that industries shall be, so far as practicable, self-regulatory.

Many national organisations assist the bureau directly in research, standardisation, and simplification, and in turn the bureau co-operates with numerous national organisations engaged in similar effort, frequently designating members of the staff to serve on committees.

The extent of these relationships is shown by the fact that at the present time the bureau is co-operating with over 200 scientific, technical, and industrial organisations. In many cases the work with any one group covers a single project, while in other cases 25 projects or more are being handled by practically every division of the bureau.

One of the most effective ways in which the bureau co-operates with American industries is through its research associate plan, referred to in past annual reports. At the close of the fiscal year there were 68 of these associates stationed at the bureau, representing 38 industries and associations.

Among the recent investigations the following are included :—

A Study of the Problems Relating to the Maintenance of Interior Marble, by D. W. Kessler(35 c.).

Some Vulcanisation Tests of Guayule Rubber, by D. Spence and C. E. Brown (5 c.). The results indicate that properly prepared Guayule rubber compares favourably with plantation Hevea rubber.

The Determination of the Copper Number of Paper, by B. W. Scribner and W. R. Brode (5 c.).

The copper number is a determination applied to paper to find its probable resistance to deterioration, and to control manufacturing processes so as to obtain satisfactory permanency. It is a measure of the amount of impure forms of cellulose which tend to weaken the paper and induce deterioration of the paper fibre.

Determination of the copper number of high-grade rag-fibre bond papers is difficult owing to the resistance these hard, tough papers offer to the usual procedure employed for this determination. A modified method is described by which greater accuracy in testing such papers was obtained and which is recommended in part at least for general usage in testing paper or pulp. It it patterned after the method of Gault and Mukerji and that of Staud and Gray. The variation from these methods considered of prime importance is grinding the test specimens to a finely divided condition. A grinder devised especially for the purpose is described in detail.

The Manufacture of Lime (Circular 337, 45 cents).

Intensification and Reduction. By E. J. WALL, F.C.S. Pp. 40. 1928. Price $1. American Photographic Publishing Co., Boston, U.S.A.

The American Annual necessarily appeals more to pictorialists whilst this work is of greater interest to scientists since it deals with an important application of chemistry to photography. The processes of intensification and reduction are only resorted to when no alternative is possible for they are seldom entirely satisfactory. Mr. Wall has made a very exhaustive search of the literature and his account of the various processes is an important contribution to the scientific side of photography. One minor error has been noticed, the second equation on page 11 is wrong.

J. G. F. D.

COLLIERIES TAKING UP COAL CARBONISATION.

It is officially announced that a further battery of retorts for the distillation of coal will be erected during the next three months by Low Temperature Carbonisation, Ltd., at Barugh (Yorkshire). Improvements will be incorporated, in respect of which the Company holds a valuable new patent.

It is understood that the Company has opened negotiations with local groups for the establishment of carbonisation works on a large scale at Newcastle and Nottingham; and it is expected that arrangements will shortly be concluded for the erection of two more plants in addition to those to be erected at Askern, Yorks.

The Company is testing samples of coal from nearly thirty colliery companies, who have inquired as to the suitability of the process for use at their collieries, and a number of colliery engineers have visited the works. Representatives from India, South Africa, Australia, Chile, America, Germany, Belgium, and Japan, have entered into negotiation with the Company with regard to the possibility of extending the process to collieries abroad.

FORTHCOMING EVENTS.

INSTITUTE OF METALS.

Sheffield Local Section, at Applied Science Department, University, St. George's Square.—Friday, March 9, at 7.30 p.m.—"Special Alloys in Relation to the Corrosion Problem." By W. R. Barclay, O.B.E.

OIL AND COLOURMEN'S ASSOCIATION.

Manchester Section, at Milton Hall, Deansgate.—Friday, March 9, at 7.30 p.m. —"Researches on the Preservation of Iron and Steel with Paint." By J. N. Friend, D.Sc., Ph.D., F.I.C.

London, at 8, St. Martin's Place, Trafalgar Square, W.C.2. — Thursday, March 8.—"Notes on Aeronautical Paints." By E. W. J. Mardles, D.Sc., F.I.C.

PEOPLE'S LEAGUE OF HEALTH.

11, Chandos Place, London, W.1.

Wednesday, March 7, at 6 p.m.—"Crime and Delinquency." By Dr. W. A. Potts.

Friday, March 9, at 6 p.m.—"Food in Relation to Growth." By Prof. Winifred Cullis, O.B.E., D.Sc.

ROYAL INSTITUTION.

Albemarle Street, London.

Monday, March 5, at 5.15 p.m.—General Meeting.

Tuesday, March 6, at 5.15 p.m.—Prof. J. S. Huxley: "The Behaviour of Animals."

Thursday, March 8, at 5.15 p.m.—Dr. J. J. Fox: "Optics and Chemistry."

Friday, March 9, at 9 p.m.—E. A. Milne: "The Sun's Outer Atmosphere."

Saturday, March 10, at 3 p.m.—Sir Ernest Rutherford: "The Transformation of Matter."

ROYAL INSTITUTE OF PUBLIC HEALTH.

37, Russell Square, London.

Wednesday, March 7, at 4.30 p.m.—"Some Problems in Medico-Legal Practice." By G. Roche Lynch, O.B.E., M.B.(Lond.).

ROYAL SOCIETY OF ARTS.

John Street, Adelphi, London.

Wednesday, March 7, at 8 p.m.—"Some Wider Problems of Cosmogony." By J. H. Jeans, M.A., D.Sc.

Friday, March 9, at 4.30 p.m.—(Indian Meeting). Colonel I. A. E. Edwards, C.M.G.: "The Future Prospects of Civil Aviation in India." Colonel the Master of Sempill will preside.

SOCIETY OF PUBLIC ANALYSTS.

The Ordinary Monthly Meeting of the Society will be held on Wednesday, March 7, at Burlington House, London, immediately following the Annual General Meeting, when the following papers will be read: "Composition of the Fatty Acids present as Glycerides in Elasmobranch Oils." By Professor T. P. Hilditch, D.Sc., F.I.C.; "Behaviour of Indicators in the Titration of Ammonia, Sodium and Calcium Phosphates, the Methylamines, Pyridine Bases and Boric Acid." By R. T. Thomson, F.I.C.; "Cacao Tannin." By H. R. Jensen, M.Sc., F.I.C.

THE INSTITUTE OF METALS.

At the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1.

Wednesday, March 7, at 10 a.m., to 12.30 p.m.; 2 p.m. to 4 p.m. — Various papers. Annual Dinner and Dance at the Trocadero at 7 p.m.

Thursday, March 8.—Various papers.

THE ROYAL SOCIETY.

Burlington House, London.

Thursday, March 8, at 4.30 p.m.

UNIVERSITY COLLEGE, LONDON.

Monday, March 5, at 2 p.m.—"The Italian Epic." A public lecture by Camillo Pellizzi.

Tuesday, March 6, at 5.15 p.m.—"The Evolution and Classification of Fungi." First of a course of three lectures, by Mr. J. Ramsbottom, O.B.E., M.A. Other lectures, March 13 and 20.

Wednesday, March 7, at 5.30 p.m.—"The Citizen and the Librarian." A public lecture by Albert Mansbridge, Hon. M.A., LL.D.

Thursday, March 8, at 5.30 p.m.—"The Development of Mechanisation." A public lecture by Maj.-Gen. Sir John Burnett-Stuart, K.B.E.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

4,387.—I. G. Farbenindustrie Akt.-Ges.—Manufacture of stable medicinally active salts of para-amino-phenyl-stibinic acid. February 11th.

4,409.—Consortium für Elektrochemische Industrie Ges. — Manufacture of esters of vinyl alochol. February 11th.

4,225.—Deutsch, L. — Manufacture of copper-sulphate. February 10th.

3,615, 3,615.—Horsley, G. F.—Production of alfol, etc. February 6th.

4,227.—Levy, S. L.—Method of obtaining hydrochloric acid. February 10th.

Specifications Published.

265,146.—Henkel & Cie, Ges.—Manufacture of a glycerine poor in polyglycerines and containing di-glycerine.

284,859.—Petroff, G.—Process for separating and purifying sulpho-acids of high molecular weight.

284,958.—Schlaugk Ges., Dr. M.—Manufacture of sodium sulphide.

269,185.—U.S. Industrial Alcohol Co.—Method of retarding or preventing the corrosion of metal containers containing alcohol.

Abstract Published.

282,379.—Hydrocyanic acid; cyanamides.—Frank, A. R., 138, Kurfurstendamm, Halensee, and Caro, N., 8, Budapesterstrasse, both in Berlin.

Hydrocyanic acid is formed by passing ammonia and carbon monoxide at a red heat (700-800° C.) over the oxides of the alkaline earths, including magnesium, or over the hydroxides, carbonates, etc., which yield oxides on heating, or over the cyanamides which are the first product of the reaction. The treatment may be effected at ordinary or increased pressures. Industrial gases containing ammonia and carbon monoxide together with other gases such as hydrogen, nitrogen, etc., may be used. Metals or metal compounds which act catalytically to decompose ammonia or hydrocyanic acid are excluded from the reaction or their action is prevented by the addition of sulphide compounds in the gaseous or solid phase or of water.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

SOLGANAL.

486,955.—Chemical substances prepared for use in medicine and pharmacy.—Schering-Kahlbaum Aktiengesellschaft, N.39, Germany. February 15th.

PINAFORE.

486,043.—All goods in class 2 which includes chemical substances used for agricultural, horticultural, veterinary, and sanitary purposes.—J. Bibby & Sons, Limited, Bibby's Buildings, King Edward Street, Liverpool. February 15th.

480,880.—A device in a triangle and the word PROMONTA for all goods in class 3 which includes chemical substances prepared for use in medicine and pharmacy.—Chemische Fabrik Promonta Gesellschaft mit beschränkter Haftung, 166 to 172, Hammerlandstrasse, Hamburg 26, Germany. February 15th.

POETRY OF SCIENCE.

POEMS by "OPIFEX"
(*A Prominent Scientist.*)
Various Phases of Science. Pp. 106.
Cloth, Price 5/-
By Post 5/4
Chemical News Offices,
Merton House, Salisbury Square,
London, E.C.4.

JUST PUBLISHED.

RASA-JALA-NIDHI
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VOLS. I. AND II.

This is the most Comprehensive and Scientific Treatise on Hindu Chemistry, Alchemy and Medicine—a Science almost lost to Humanity several Centuries ago, and now reclaimed by

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THE
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AUTHOR OF
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Confessions of Great Souls,
History of Theological Education, etc., etc.

REA & INCHBOULD,
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THE CHEMICAL NEWS

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CONTENTS. PAGE.

Determination of e/m 145
By F. H. Loring.

Institute of Chemistry — Annual Meeting 147

General Notes:—

Economy in Combustion by Air Pre-Heating 149

The Problem of Knocking 149

Unventilated Geysers 151

Proceedings & Notices of Societies:

The Royal Society 151

The Chemical Society 153

The Geological Society 153

The Optical Society 154

U.S.A. and Other Official Publications 156

Forthcoming Events 159

New Patents 159

New Trade Marks 160

COAL, IRON AND STEEL PRODUCTION IN CERTAIN EUROPEAN COUNTRIES AND THE UNITED STATES.

The total production of coal in the six leading countries has amounted to 1,081 million tons in 1927, 946 million tons in 1926, and 975 milion tons in 1925 The total production of pig-iron of the countries however, (not including Italy) was 71,900,000 tons, 66,300,000 tons, and 65,900,000 tons in the years 1927, 1926 and 1925 respectively, whilst for crude steel the total production of the same countries was 82,400,000 tons in 1927, 76,500,000 tons in 1926, and 75,200,000 tons in 1925.

DETERMINATION OF e/m.

By F. H. LORING.

INTRODUCTION.

The exact determination of e/m_0 may not seem of importance in comparison with other matters as it does not give employment to labour; but history shows that Hertz's successful experiments—devised to determine whether electromagnetic disturbances are propagated as waves with the velocity of light, as they should be, according to Maxwell's electromagnetic theory of radiation—lead to the world development of wireless communication. The sequence of events can now be written thus:—Maxwell—Hertz—Marconi and others: huge development of a new industry, and as a result much labour is employed and a great deal of money put into circulation.

It is therefore reasonable to assume that the precise determination of the various constants entering into the mathematical treatment of phenomena will lead to something of considerable industrial importance. The determination of e/m_0 is quite as important as any of the other constants, especially since it affords a check on the equations that are inherently essential to the extension of knowledge.

The first part of this article is devoted to the best determination of e/m_0 by European continental physicists, although the discovery of the electron (e) of definite but small mass (m) relative to that of the hydrogen atom together with its measurement and the formulation of methods of measurement is largely due of Sir J. J. Thomson, of Cambridge (see *Phil. Mag.*, 1897, XLIV, 293).

The second part is devoted to the more recent work by American physicists with the same object in view; and the Americans, too, can lay claim to a share in the credit of elucidating the electron, for R. A. Millikan was the first to determine with a high degree of accuracy its electric charge, by weighing this charge, so to speak, in an electric field, involving a capture and loss method so well known it is not necessary to say more here.

Historically the full sequence of events includes other names than those mentioned here, which are set out with accompanying description in Millikan's well-known book "The Electron."

In the second part there are a number of calculations involved, in which the quantities have been adjusted by the writer,

whilst keeping within probable experimental limits, with a view of obtaining a better all-round co-ordination. The reader has only to make a few trial calculations to see that before anything like a precise value can *be obtained the decimal fractions have to be* extended beyond the experimental values or they have to be slightly adjusted in certain cases.

By making these adjustments, repeating figures occur in several places. An example will illustrate this feature. Suppose that an experimental value is found to be 6.664; and an earlier one known to be 6.673. Now a mean value would be 6.6685. This might *be too high. By trial in connection with* other values let it be assumed that it seems too high, whereas 6.664 tends to be too low. In this case it would be assumed that the truer value would be $6.\dot{6}$. It is not, however, known how far the repeating figures might extend, but the error tends to lessen as the decimal fraction deepens; that is to say, the remote 6's in this example make very little difference. $6.\dot{6}$ is therefore adopted in preference to 6.664 or 6.668. It is really a case of compromise in which the benefit of the doubt is cast in favour of repeating figures. They must be regarded, *nevertheless, as a temporary expedient*, but worth trial.

DETERMINATION OF e/m_0 BY EUROPEAN CONTINENTAL PHYSICISTS.

The determination of the charge of the electron (e) relative to its rest mass (m_0) by means of electric and magnetic fields does not involve knowing the value of either e or m. This ratio has been determined many times by continental physicists, with which this section of the article deals.

Taking a period from 1902 to 1909, the following determinations have been recorded, this particular selection being one made by Prof. E. H. Barton when abstracting K. Wolz's paper (*Annalen*, 1909, xxx, 273) in *Science Abstracts*, 1909.

TABLE I.

Observer.	Year.	Method.	e/m_0*
Seitz	1902	Kathode rays. Mag. & elec. def.	1.87
Kaufmann	1902	Becquerel rays. Mag. & elec. def.	1.845
Wehnelt	1903	Incand. electrolyte. Mag. def. & voltage ...	1.4
A. Becker	1905	Kathode rays. Mag. def. & voltage	1.847
Kaufmann	1906	Becquerel rays. Mag. & elec. def.	1.884
P. Weiss & Cotton	1907	Zeeman effect...	1.767†
Bestelmeyer ...	1907	Kathode rays. Mag. & elec. def.	1.72
Stettenheimer ...	1907	Zeeman effect...	1.791†
Bucherer	1908	Becquerel rays. Mag. & elec. def.	1.763‡
Classen	1908	Incand. electrolyte. Mag. def. & voltage ...	1.773
Gmelin	1909	Zeeman effect...	1.771

* Values below × 10^7 in E.M.U.
† According to Gmelin.
‡ Corrected later, which would raise the value above this one.
Classen's value here is the one cited by Cunningham (see below) but omitted in the next table.

It appears that Wolz by the method of Bucherer (see *Annalen*, 1909, XXVIII, 513), *using Becquerel rays* (β*-rays : fast-moving* electrons from radio-atoms), corrected for the relativity effect (Lorentz formula), due to increase of mass with velocity, obtained a value thought then to be very accurate, *viz.* : 1.7674 × 10^7.

Cunningham in his "Principle of su'ity," 1914, page 158 (or, see, prefer-m his "Relativity and the Electron isc," 1915, page 66) makes another mn covering a later period and gives, 172, [illegible], the e/m values corrected 26, Germans for the relativity mass change effect, so that they may be compared with the e/m values for slow moving-electrons. The agreement is satisfactory, but the relativity effect is not of special consideration here.

Now these later values are more concordant than those of Table I; and, as the technique and knowledge improves with time it becomes possible to bring these values up to date, as it were, by adding, in this case, Wolf's 1927 determination of e/m_0; for, by assigning weights to the respective values, so that the last one has the greatest weight, it is an easy matter to arrive at a weighted

mean value—making of course a judicious selection. Such a method would not do if the later value were a confirmed determination of much higher precision. So far as the writer's knowledge extends in this direction the later values are not sufficiently precise to stand alone, hence the method adopted which is shown in Table II. Literature does not appear to record any noteworthy determinations (of the kind mainly considered here) within the long interval shown in the table, therefore Wolf's value is given considerable weight. No scheme can be perfect, and no two workers will probably agree on the choice of values. However this may be, Cunningham's selection is made the basis here (beginning at 1909), with Wolf's value added.

TABLE II.

Gmelin (*Annalen*, XXVIII, 1079)	1909	1.771	×	9	=	15.9390
Wolz (*Annalen*, XXX, 273)	1909	1.7674	×	9	=	15.9066
Malassez (*Ann. Chim. Phys.*, XXIII, 491) ...	1911	1.769	×	11	=	19.4590
Bestelmeyer (*Annalen*, XXXV, 909)	1911	1.766	×	11	=	19.4260
Alberti (*Annalen*, XXXIX, 1173)	1912	1.766*	×	12	=	21.1920
Neumann (see Schaefer)	1913	1.765	×	13	=	22.9450
F. Wolf (*Annalen*, LXXXIII, 849)	1927	1.7679	×	27	=	47.7333
						92)162.6009
						1.7674

* This is the corrected value by C. Schaefer, *Phys. Zeit.*, 1913, XIV, 1117.

It will be seen that beginning at 1909, and therefore omitting the 1908 values and those earlier, gives by this method a weighted mean (adjusted by year) of 1.7674 × 10^7.

This value comes very near to one calculated by the writer's method of adjustment, which was 1.767488 × 10^7 (see *Chemical News*, 1927, CXXXV, 17). Using slightly modified values for c and R_{inf} (see *Chemical News*, 1928, CXXXVI, 33) the writer's value comes out at 1.767496 × 10^7. These two or three values agree well with that of Wolz given in Table II. Wolf's determination is also practically in agreement with them as his 9 is uncertain.

From these considerations the best value for e/m_o is

1.7674 x 10^7 in E.M.C.G.S. units

ADDITIONAL REFERENCES.

In addition to the selection of values above and the corresponding references, the following may be noted in brief:— C. Runge and W. Lohmann (1907); J. Classen (1908); W. Lohman (1908); O. v. Baeyer and F. Gehrcke (1909); C. A. Proctor (1910) see below; K. Lerp (1910); R. Fortrat (1912); C. Schaefer and G. Neumann (1914-16); F. Paschen (1916); L. Flamm (1917); H. Busch (1922); H. D. Babcock (1923) see below; R. T. Birge (1926) see below; W. V. Houston (1927) see below. See also Sommerfeld: "Atomic Structure and Spectral Lines," 1923; H. Geiger and K. Scheel: "Handbuch der Physik," XXII; E. Marx: "Handbuch der Radiologie," V.

(*To be Continued.*)

INSTITUTE OF CHEMISTRY.

The Fiftieth Annual General Meeting of the Institute of Chemistry was held at the Institute in Russell Square on March 1, Mr. E. Richards Bolton, Vice-President, presiding in the unavoidable absence of Professor Arthur Smithells, President.

In moving the adoption of the Report of Council, Mr. Bolton read an address from the President in which—referring to the recent jubilee celebrations of the Institute—he said that it would enter upon its second half century with the prestige of a fully acknowledged national institution. He emphasised the importance of the loyal co-operation of all the members, in whatever branch of the profession they might be engaged, in order to promote by the only really effective means the complete and solid organisation of the profession of chemistry, as well as for its own prestige as for the service of the community. During the past twelve months, the membership had increased by 202 to a total of 5,888 Fellows and Associates. There had been some difficulty in placing newly qualified members, and there had been a certain tendency for

them to turn to other careers; but it was a good thing that men of science should be diffused among the practitioners of other professions and in the business world. The number of members known to be without appointment, however, was less than 2 per cent.

The Associateship of the Institute did not constitute merely an additional diploma obtainable by those who had reached a certain standard of knowledge and obtained certain qualifications, but it was a recognition by the responsible professional body that the graduate was competent and, as an individual, was personally acceptable to the profession as a whole. By his adherence to a definite code of professional ethics he should, moreover, be acceptable to prospective employers and to the community generally as one who stood for the highest ideals of the professional man.

A great many things had happened during the war, and a great many things had happened since, to direct attention to the education of the chemist. The science itself had not only grown abundantly in these years, but it had been subject to great changes. Special branches of chemistry, pure and applied, had been stirred to luxuriant growth, and the part which chemistry had to play in human affairs was constantly enlarged. The determination to keep our country leading in chemical industry was evident from recent developments among its greatest manufacturing concerns, from the forward policy they were adopting in the promotion of research, and their employment of highly trained scientific staffs. These things had created an unprecedented stir in the centres of chemical education. He was not satisfied that the training of the university chemical student was, generally speaking, all that it should be: he felt particularly alarmed by the increasing burden of memorised intellectual matter—he would not call it knowledge—which the student had usually to carry to the examination room. It was necessary to review the degree system and he thought that the time had come for an exchange of opinions on the subject. At one end of the university curricula lay the school course, and at the other end, in some cases at least, the chance of a further period of preparation on which much might be acquired that would help the young chemist to orient himself in industrial life. He hoped, therefore, that the Institute would be able to convene a conference in the near future to consider generally the education of the chemist. They did not want to stereotype chemical curricula, but they might well combine in getting rid of difficulties and in improving their ways.

The President also referred to the representations which had been made by the Institute to public authorities in order to bring about a better realisation of the value and importance of professional chemical services. It was especially difficult to induce public authorities to understand the aims of, and the responsibility involved in, those branches of work, such as the protection of the food and water supplies of the community, and the regular examination of the gas supply; for the benefits derived from this work were not directly obvious. Yet such services were essential to the public welfare, and the result of neglecting to take advantage of them at any time be disastrous. The Institute protested against the ignorance which prevailed in these matters and the shortsightedness which, by imposing mean conditions on public chemical appointments, prevented the full use being made of the services which the profession could render. There was in too many quarters evidence of the same shortsightedness on the part of employers who did not always realise that if they were to secure men who were to work with their brains and be able to give of their best, means must be allowed for life at a reasonable standard of comfort.

Next, referring to the activities of the Local Sections of the Institute, the President said that their existence in the principal centres throughout the country, made the corporate life of the profession more real, and it had been a great satisfaction to the Council to note that their meetings during the past year, held independently or jointly with other bodies, had been remarkable for the number of really valuable papers which had been contributed and the useful discussions which had been held.

In conclusion, he expressed his appreciation of the services rendered by the Officers and Members of Council and by the honorary Officers and Committees of the Sections.

The Officers and Members of Council for the ensuing year were elected as follows:—

PRESIDENT:

Professor Arthur Smithells, C.M.G., D.Sc., F.R.S.

VICE-PRESIDENTS:

Arthur J. Chapman; Dr. Harold G. Colman; Ernest M. Hawkins; Prof. G. G. Henderson, D.Sc., F.R.S.; Dr. Robert M. Pickard, F.R.S.; Prof. J. F. Thorpe, C.B.E., F.R.S.

HON. TREASURER :
Patrick H. Kirkaldy.

MEMBERS OF COUNCIL :

Dr. T. Lewis Bailey; Prof. A. A. Boon, D.Sc.; Dr. P. E. Bowles; Dr. F. D. Chattaway, F.R.S.; Dr. G. C. Clayton, C.B.E., M.P.; Dr. William Clayton; Prof. J. W. Cobb, C.B.E., D.Sc.; W. H. Coleman; Dr. R. T. Colgate; Dr. Frankland Dent; Prof. J. C. Drummond, B.Sc.; Dr. Bernard Dyer; G. D. Elsdon, B.Sc.; F. G. Edmed, O.B.E.; Lewis Eynon, B.Sc.; A. G. Francis, B.Sc.; Dr. W. H. Gibson, O.B.E.; C. M. W. Grieb, B.Sc.; Edward Hinks, M.B.E., B.Sc.; Dr. H. H. Hodgson; Bernard F. Howard; Prof. C. K. Ingold, D.Sc, F.R.S.; A. W. Knapp, B.Sc.; Dr. D. W. Kent-Jones; Dr. L. H. Lampitt; Dr. A. G. G. Leonard, B.Sc.; William Marshall; B. G. McLellan; C. Ainsworth Mitchell, M.A.; L. G. Radcliffe, M.Sc. Tech.; Dr. Alfred Reé; Dr. E. K. Rideal, M.B.E.; P. W. Tainsh, O.B.E.; H. E. Monk; Dr. D. F. Twiss; Oliver Trigger, M.B.E.; J. H. Totton, B.A., B.Sc.; J. Adam Watson, A.C.G.I.; A. W. M. Wintle.

GENERAL NOTES.

ECONOMY IN COMBUSTION BY AIR PRE-HEATING.

A notable feature of combustion engineering developments is the increasing use of pre-heated air, not only in the newer system of pulverised-fuel firing, but also in mechanical stoker firing. While formerly an air temperature of 200°F. was usuallly regarded as the maximum permissible, improvements in stoker design now permit temperatures up to 500°F. In view of the economy affected, it is not surprising that air preheating is now a standard feature in modern power-house practice and that the high heat recovery of the rotary regenerative type of pre-heater is being used to full advantage in the latest power stations being built under the Electricity Scheme.

At the new Brimsdown Station of the North Metropolitan Electric Power Supply Co. operating on pulverised fuel air preheaters of this type manufactured by Howden-Ljungstrom Pre-heaters (Land) Ltd., have been adopted for all the boilers. The high air temperature economically obtained with the regenerative pre-heater is most advantageous in pulverised fuel fired boilers and the low exit temperature of the gases is an indication of the high overall efficiency of the boiler units.

The regenerative contraflow air pre-heater is becoming well established, as will be seen from a glance at the recent orders obtained for this apparatus by Howden-Ljungstrom Pre-heaters (Land) Ltd. Within the last few weeks this type of air pre-heater has been adopted for the boilers of one of the new power stations in this country, and also for the power station extensions at Barrow-in-Furness, Burton-on-Trent, Northampton, Oxford, and the Riverside Power Station, Shanghai.

Howden-Ljungstrom Pre-heaters (Land) Ltd., recently claimed that 48% of their orders from Power Stations were repeat orders and this appears to be maintained in the above list as at Shanghai, Northampton and Oxford the electricity undertakings have already had previous experience of the Howden-Ljungstrom pre-heaters.

BRITISH COAL MINING.

Production of coal in the last quarter of 1927 was about 1½ million tons larger than in the preceding three months, and the total for the year was 252 million tons as against 243 million tons in 1925. Prices, which had been inflated as a result of the coal stoppage of 1926, declined substantially after the first quarter of last year. Shipments abroad were a trifle above those of 1925.

DEPARTMENT OF OVERSEAS TRADE.

SOUTH AUSTRALIAN STATE FINANCE REPORT.

The Department has received a copy of the *First Progress Report of the Special* Committee on State Finance, which can be consulted by British firms interested on application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. Dunedin Chamber of Commerce Report is also available.

THE PROBLEM OF "KNOCKING."

A VAPOUR-PHASE PROCESS OF REFINING.

The claims of the Gyro vapour-phase process of refining petroleum as a solution of the problem of "knocking" are advanced by Lt.-Col. W. A. Bristow, the well-known aeronautical and consulting engineer, in a memorandum recently issued to petrol companies.

Colonel Bristow points out that, as a result of the increasing difficulty of supplying petrol containing a sufficiently high proportion of aromatics to prevent detonation troubles, the way has been prepared for fuels doped with metallic salts which, he declares, have certain disadvantages both to refiners and users.

Examining the possibilities of the Gyro vapor-phase process as an alternative to high temperature, high pressure cracking processes, Colonel Bristow points out that the former is the first of its kind to be in full commercial operation. Plants capable of refining a total of 3,000 barrels daily are working in Montreal, Cabin Creek (W. Virginia) and Toledo (Ohio), and four new licensees on the American Continent will refine a further 10,000 barrels daily. Samples of fuel obtained from a demonstration plant in this country have, by Government test, confirmed independent figures obtained in America.

Colonel sets out the following advantages of the Gyro process :—

(a) It works at low pressure, only a few pounds being required to circulate the charging stock vapour through the converter. There is no danger point from pressure in the whole plant.

(b) The plant required is of such a nature that it can be economically laid down in either small or large units and the cost of installation is no greater than that attaching to any other type of plant.

(c) It is easy and inexpensive to maintain, and parts of the converter can be changed without shutting down operations.

(d) The process is suitable for a much wider range of charging stock than is normally dealt with by other processes, certainly a very much wider range than can be successfully dealt with by the high pressure, high temperature cracking processes.

(e) The product is uniform in character and is easily refined. It is put on the market free from strong smell, gumminess, or other features rendering it objectionable in use, and it is water white.

(f) The product, in addition, has the great advantage of containing a very high percentage of aromatics, normally about 40 per cent., and on recent tests on aviation engines in this country, it showed to be equal to a benzol-petrol mixture with 50 per cent. benzol. The fuel has been tested to minus 100° C. without clouding or material increase of viscosity.

(g) The following table shows the yields of petrol, fuel, oil, and rich gas from three different representative classes of charging stocks :—

	Gas oil	Topped mid-continent crude	*Spindle top crude
Motor fuel	60	48.7	46.9
Fuel oil	15	31.0	46.8
Gas	30	24.3	9.0
Fuel consumed	16	13.0	12.5

* Note. Spindle top crude contains 8.4 per cent. gasoline.

The gas has a calorific value of about 1,800 B.T.U.'s per cu. ft.

It will be observed that the total products exceed the weight of the charging stock, but this is due to the hydrogenation, which is part of the process.

The general adoption of fuel manufactured under this process, says Colonel Bristow, would result in the following alterations in the present position :—

1. Petrol companies would be relieved of the obligation to add benzol to any of their fuels, and even for high compression aviation engines it is doubtful whether recourse would have to be made to mixtures containing metallic salts.

2. There would be no need for the ordinary motorist to resort to petrol containing metallic salts as Gyro petrol, or ordinary petrol blended with Gyro petrol, would do all that was required.

3. The fuel manufactured under the Gyro process can itself be used for enrichment, as for normal purposes such a high aromatic content is unnecessary.

4. The cost of the product would be reduced, because from a refining point of view the process is highly efficient, while, from a production standpoint, the process is continuous and there is practically no down time. Also a much wider range of charging stock can be utilised.

5. War-time shortage of benzol would be overcome if petroleum refiners could produce from their own resources fuel with a high aromatic content.

SET OF LANTERN SLIDES AVAILABLE FOR LECTURERS.

Arrangements have been made by the Office of the High Commissioner for Canada in London, and co-operation with the

Dominion Department of Mines at Ottawa, for the preparation of a set of lantern slides illustrating primarily Tours A and B taken by the Delegates attending the Second (Triennial) Empire Mining and Metallurgical Congress held in Canada in August-September, 1927.

It is believed that these slides may be found of service to mining engineers and others in this country who may give lectures from time to time on Canadian mining matters generally, and application for the loan of the slides should be made to the secretary, Office of the High Commissioner for Canada, the Canadian Building, Trafalgar Square, London, S.W.1.

UNVENTILATED GEYSERS.

The Bristol City Council is taking definite action to prohibit the use of unventilated geysers and water-heating appliances in bathrooms.

In consequence of the number of bathroom accidents that have arisen from insufficient ventilation and inadequate gas fittings, the Corporation has framed two bye-laws which have been incorporated in the Bristol Corporation Gas Act, 1926, and are now awaiting confirmation by the Ministry of Health. The bye-laws specify :

(1) That the window opening into the external air shall be of not less than 4 feet superficial area exclusive of the frame; and that a flue pipe of adequate dimensions to carry off the products of combustion shall be affixed with a suitably constructed " baffle " as high as possible in the bathroom and a cowl at the extremity.

(2) That where the hot water appliance is not of the geyser rapid water-heating type there shall be in lieu of the flue pipe " suitable and sufficient means " of effectually disposing of any fumes.

The new bye-laws will apply not only to future installations of gas appliances, but also to existing appliances after notice has been served.

The effect of the bye-laws is to put on the person who fixes the geyser, or other appliance for providing bath water, responsibility for taking steps to ensure the removal bustion. Leading authorities of the gas industry have long contended that the standard geysers and water-heating appliances made by leading British manufacturers are absolutely safe provided that the proper ventilating pipes are attached, the appliance is competently fixed, and the user observes certain simple rules.

As it is left to the fitters to determine for themselves what are flue pipes of "adequate dimensions," or what means will effectually dispose of the fumes, it is probable that the standard instructions compiled by the National Gas Council governing the fixing of geysers will be more generally observed.

It is believed that the new bye-laws will exercise a check on the importation of cheap foreign appliances which frequently possess no ventilating equipment at all.

INDUSTRIAL TRANSFERENCE BOARD.

In connection with the recent appointment of an Industrial Transference Board to consider the problem of surplus labour in the coal mining industry, Imperial Chemical Industries Limited have informed the Transference Board that, realising the magnitude of the problem and its importance from a national point of view, they are prepared to give sympathetic consideration to the employment within their organisation of as many ex-miners as possible as and when opportunities occur.

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.

The following papers were read at the meeting held on February 9 :—

On the Extraction of Electrons from Cold Conductors in Intense Electric Fields. By O. W. RICHARDSON, F.R.S.

The attraction of an electron by its mirror image in a conductor is treated as a Schroedinger wave problem. The sharpness of the photo-electric effect at a metal surface is accounted for. The field currents from cold conductors are found to be given by the expression

$$A\,(X^{-\frac{1}{2}} + b)^2 e^{-cX^{-1}},$$

where X is the electric intensity, $c = 8\pi^2 m e^{\frac{5}{2}}/2h^2$, b is a more complicated constant made up of the same absolute elements and the lattice constant of the metal. The constant A is undetermined in the present state of the theory. This formula agrees well with the experimental data. The result implies that electrons are being generated

at a rate proportional to $(\bar{\psi}\psi)^{\frac{3}{2}}$.

The Restored Electron Theory of Metals and Thermionic Formulæ. By R. H. FOWLER, F.R.S.

This note amplifies the recent work of Sommerfeld on the electronic theory of metals by applying his ideas to thermionic phenomena. The equilibrium state of an assembly consisting of a heated metal and an atmosphere of free electrons is calculated. It appears that the vapour pressure has twice the commonly accepted value owing to the two orientations of each electron. This result is then applied to the theory of thermionic emission, and it follows that in the formula for the saturation current, $AT^2e^{-\chi/kT}$, A has the value 120 $(1 - r)$ amperes/cm^2, where r is the fraction of electrons reflected on striking a metal surface. This value is in excellent agreement with the best observations on A and r, whereas the older value 60 $(1 - r)$ only agrees with observation when r is ignored, an approximation for which there is no experimental or theoretical foundation.

The Quantum Theory of the Electron. By P. A. M. DIRAC. Communicated by R. H. Fowler, F.R.S.

In order to make the quantum theory, when applied to atomic structure, agree with observation, one has had to assign to each electron a spin and a magnetic moment. It is here shown that this is not necessary, and that agreement with observation can be obtained without arbitrary assumptions by a correct relativistic application of the general quantum theory to a point-charge electron. The Hamilton function on which the present theory is based is linear in the energy and momentum. It is found that the spinning electron model, applied in the previous non-relativistic way, is justifiable for many purposes. The motion of an electron in a central field of force is worked out, and the energy levels obtained are shown to be the same as those given by the model in the first approximation for a Coulomb law of force.

On a Minimum Proper Time, and its Application to (1) the Number of the Chemical Elements, (2) Some Uncertain Relations. By H. T. FLINT AND O. W. RICHARDSON, F.R.S.

The existence of a minimum proper time h/m_0c^2 is deduced by a method which is independent of the assumptions about the metrics of space and times used previously. It is shown to lead to an upper limit $\left(\frac{n}{n+1}\right)^{\frac{1}{2}} c$ on the velocity of an electron in an atom in an orbit of total quantum number n. This involves an upper limit (97) on the atomic number of any chemical element and also an upper limit on the quantum number of an intranuclear orbit. This limit is a function of the atomic number of the nucleus. It also involves some uncertainty relations whose implications are discussed.

Papers read in title only :—

Some Cases of Instability of Fluids. By H. JEFFREYS, F.R.S.

The problem of the instability in a liquid produced by heating below is rediscussed by a formally accurate method. Numerical results are obtained for the case where the fluid is enclosed between two perfectly conducting solid boundaries; the vertical gradient of temperature needed to cause instability is found to be rather greater than in a previous solution. An explanation is given of the fact that the honeycomb structure is not developed when the liquid is flowing, being replaced by a division into long strips. It is found that there is a formal analogy between this problem and G. I. Taylor's problem of the stability of liquid between two rotating cylinders, which leads to an explanation of the fact that the first disturbances to develop in Taylor's work were symmetrical about the axis. In atmospheric problems the earths rotation will have a considerable effect in modifying the motions produced by excessive heating below; this will probably be in the direction of making the departures from the adiabatic gradient needed to cause instability greater than in the absence of rotation (though they will still be very small) and of confining the ascending currents to regions of smaller horizontal extent.

The Kinetics of the Combination of Hydrogen and Oxygen. By C. N. HINSHELWOOD AND H. W. THOMPSON. Communicated by Sir Harold Hartley, F.R.S.

An examination has been made by a static method of the complete course of the combination of hydrogen and oxygen, at constant temperature and volume, over a range of temperature extending from the region of purely catalytic surface reaction up as nearly as possible to the point where the combination ceases to be isothermal and passes into explosion.

In the last fifty degrees of this range a reaction comes into prominence, which is

quite different from the low order heterogeneous reaction. It is of high but variable order, the influence of pressure being on the average approximately that corresponding to a reaction of the fourth order; it is strongly autocatalysed by steam, and has a high temperature coefficient. At these high temperatures the normal positive catalytic effect of the walls of the reaction chamber gives place to a negative effect, which may be due to the catalytic destruction of an autocatalyst for the main reaction, or the interruption of "reaction-chains," or to both causes. It is concluded that the reaction measured is the true gas reaction between hydrogen and oxygen.

THE CHEMICAL SOCIETY.

Papers read on Thursday, March 1 :—

The Complex Salts of Bivalent Platinum with αβγ-triaminopropane. By F. G. MANN.

When potassium chloroplatinite is treated with αβγ-triaminopropane trihydrochloride, co-ordination occurs between the metal and the α- and β-amino-groups of the amine, giving dichloro-(triaminopropane-γ-monohydrochloride)-platinum, $[Cl_2Pt, NH_2.CH_2.CH(NH_2).CH_2.NH_2, HCl]$, a compound having an asymmetric β-carbon atom. Its constitution has been verified by resolution into optically active forms.

When potassium chloroplatinite is treated with the free base, co-ordination occurs, giving two new types of complex platinous salts, bis(triaminopropane-γ-monothiocyanate)platinous dithiocyanate, $[Pt\{NH_2 CH_2.CH(NH_2).CH_2.NH_2,HSCN\}_2](SCN)_2$, a compound identical in type with the cupric compound and bistriaminopropaneplatinous diiodide, $[Pt\{NH_2 . CH_2 . CH(NH_2) . CH_2 . NH_2\}_2]I_2$.

The Constitution of Thebenine. By J. M. GULLAND AND C. J. VIRDEN.

The positions of the methoxyl and hydroxyl groups of thebenine have been determined by Pschorr, but the evidence for placing the side chain in position 5 is inconclusive. Various attempts have therefore been made to convert 3 : 4 : 8trimethoxy-5-vinylphenanthrene, obtained by the complete alkylation and exhaustive methylation of thebenine, into 3 : 4 : 5 : 8-trimethoxyphenanthrene, in order to compare this with a synthetical product of known constitution. These attempts were unsuccessful owing to the ease with which derivatives of 3 : 4 : 8-trimethoxyphenanthrene-5-carboxylic acid pass into the lactone of 3 : 8-dimethoxy - 4 - hydroxyphenanthrene - 5 - carboxylic acid. The vinylphenanthrene derivative was therefore reduced to 3 : 4 : 8-trimethoxy-5-ethylphenanthrene, which proved to be identical with a specimen prepared from 2-nitroveratraldehyde and 6-methoxy-3-ethylphenlyacetic acid. The side chain is thus in position 5.

Properties of Conjugated Compounds. The Constitution of the Sodio-esters Derived by the Michael Reaction as Related to the Additive Process. By E. H. FARMER AND C. D. LANGFORD.

The mechanism of the "Michael" addition of sodio-esters to conjugated compounds is important, as representing the employment of unsymmetrical addenda of a characteristic type, in its relation to the general question of conjugated addition.

The paper deals with an examination of the addition of sodio-esters to ethylenic esters.

The Hydrogenation of Certain Extended Heterogeneous Systems. By J. T. EVANS AND E. H. FARMER.

The relation of the mechanism of hydrogen addition to the general question of conjugated addition is obscured by apparent non-conformity in the mode of attack by the addendum. Whilst reduction of a conjugated compound to the dihydro-stage is usually not possible in a catalytic process, reduction by freshly generated hydrogen has been held to lead only to "terminal" dihydro-products. Such terminal products do not inevitably arise with common reducing agents.

Reduction of sorbyl methyl ketone with aluminium amalgam gives mainly the compound (I); a simple dihydro-ketone (II or III) has not been isolated.

$CH_3.CH : CH.CH - CO$
$\quad\quad\quad\quad\quad | \quad\quad >CH_2$ (I)
$CH_3.CH : CH - CH - C(OH).CH_3$

$CH_3.CH_2.CH : CH.CH_2.CO.CH_3$ (II)

$CH_3.CH : CH.CH_2.CH_2.CO.CH_3$ (III)

Sorbic acid, however, yields on reduction with aluminium amalgam or sodium amalgam (acid or alkaline solution), a mixture of δβ- and δγ-dihydrosorbic acids. Further experiments on the reduction of the muconic system have again shown that no recognisable amounts of δα-dihydro-products are obtainable.

GEOLOGICAL SOCIETY.

The following paper was read at the meeting held on February 22, 1928:—

The Pre-Cambrian Complex and Associated Rocks of South-Western Lleyn (Carnarvonshire). By CHARLES ALFRED MATLEY, D.Sc., F.G.S. With a Chapter on the Petrology of the Complex, by Edward Greenly, D.Sc., F.G.S.

The Pre-Cambrian complex of Lleyn occupies the coastal strip from Nevin to Aberdaron and Bardsey Island, the geology of which was described by the Author in 1913, and is a detached 'region' (the Mainland Region) of the Mona Complex of Anglesey. Its age is definitely Pre-Cambrian, and its special structures and metamorphism were impressed on it before Cambrian times. It is bounded on the east by a great thrust which has driven it over Ordovician strata and the Sarn granite.

Its members are now correlated with those of Anglesey. The Gneisses, several members of the Bedded Succession, the Plutonic intrusions, and the 'Penmynydd Zone of Metamorphism' are all represented. The Holyhead Group is absent.

The Gneisses are always found near the boundary-thrust. Both their basic and their acid members are almost identical with those of Anglesey. Their crystallisation and foliation are older than the deposition of the Bedded Succession.

Most of the region is occupied by the Gwna Group. On a low horizon of this are the laminated Aber Geirch phyllites, above which come alternating grit and phyllite, quartzites and limestones. There is a strong development of ellipsoidal spilitic lavas, with tuffs, limestone, and jasper, and sills of albite-dolerite. All members of the group, except the Aber Geirch phyllites, are mostly in the condition of a schistose autoclastic mélange. Part of the group is in the anamorphic condition known in Anglesey as the Penmynydd Zone Metamorphism, being now mica-schists, some of which may, however, be metamorphosed Fydlyn Beds.

Resting on the Gwna Beds are some 300 feet of quartz-albite dust-rocks (Gwyddel Beds). They may be a special facies of the Skerries Group of Anglesey, with a representative of the Tyfry Beds at theis base.

The gabbros are akin to those of Anglesey, and are regarded as plutonic intrusions belonging to the complex.

The tectonics and foliation of the complex resemble in almost every detail those of the complex in Anglesey. On the working hypothesis of recumbent folding adopted for Anglesey, Dr. Greenly is inclined to regard the Mainland Region as the lower uninverted limb of a recumbent fold (a Lleyn Fold) belonging to a higher tectonic horizon than those now found in Anglesey.

The Arenig rocks at Aberdaron form a faulted syncline over-ridden on the west and north by the complex, and faulted against it on the east. They probably occur as a 'window.' About 1,000 feet of sediments belonging to the *extensus* zone and 200 feet of *hirundo* beds are exposed. They contain a thick sill of albite-dolerite, which transgresses a zone of fine-textured pyroclastic cherts containing abundant sponge-spicules.

Many basic dykes are exposed in the complex, of which the great majority are Palæozoic (Post-Llandovery and probably Post-silurian), but earlier than the great thrusting movements after the close of Silurian time. Three Tertiary dykes have been found.

Many thrusts and shear-planes later than the complex are found in the complex itself, cutting across the foliation and the autoclastic mélange, and disrupting the Palæozoic dykes. They were produced by minor movements during the general movement which drove the complex of Lleyn over the Ordovician strata. The boundary-thrust is certainly a great rupture, which shows no sign of dying out at either end of the exposed part of the complex. The extent of its overdrive cannot be determined, but it should probably be measured in terms of miles, and may have been sufficient to sever the whole plexus of Palæozoic dykes in the complex from their roots.

THE OPTICAL SOCIETY.

At a well-attended meeting of the Optical Society at the Imperial College of Science and Technology, South Kensington, on February 9, 1928, the President, Dr. R. S. Clay, in the chair, Mr. D. Baxendall gave a brief outline of the history of the collection of scientific instruments housed in the Science Museum. This account was illustrated by lantern slides depicting a few of the larger exhibits and also by slides showing the removal of these from the West Galleries to the New Galleries. A humorous touch was introduced by the exhibition of slides showing the removal of the "Solar

System" and "Galileo" to the New Galleries, as conceived by a famous cartoonist.

By the kind permission of the Director, Colonel Sir Henry Lyons, F.R.S., the company then proceeded to view the collection of optical instruments in the Science Museum under the guidance of Mr. Baxendall. The visit was much appreciated by those present.

Votes of thanks to the proprietor and to Mr. Baxendall were accorded with acclamation.

At the meeting held on February 16, at the Imperial College of Science and Technology, the President, Dr. R. S. Clay, in the chair, the following papers were read :—

An Investigation into the Beam from a Standard Lighthouse Lens. By W. M. Hampton, Ph.D., B.Sc., F.Inst.P., A.I.C., of Messrs Chance Bros., and Co., Ltd.

In this paper the distribution of light from a third order Fresnel panel was measured, using two different light sources, a standard petroleum vapour burner and a 3 kw. lighthouse cruciform lamp.

A complete theoretical discussion of the factors affecting beam candle-power is worked out and tables are provided for the calculation of the beam candle-power from any apparatus using any light source.

A discussion followed in which Mr. J. P. Bowen, Engineer-in-Chief to the Corporation of Trinity House, at whose suggestion the research described in the paper was carried out, pointed out the mportance of such work to those responsible for Lighthouse services. He expressed the hope that the Members of the Society would give such matters their careful consideration.

Mr. J. R. Wharton, Professor Pollard and the President, among others, took part in the discussion, to which Dr. Hampton replied.

Cordial votes of thanks were accorded to Dr. Hampton and Messrs. Chance Bros.

The "Absolute" Hartmann Test. By Dr. R. Kingslake, M.Sc., A.R.C.S., D.I.C., F.R.A.S.

In this paper the author pointed out that according to the ordinary methods of performing the Hartmann test, the assumption is made that all the rays cross the optical axis. As a matter of fact, this is very far from the truth, especially in the case of the large astronomical objectives and mirrors to which the Hartmass test is most generally applied. In the present paper a brief description is given of a modified test in which each "ray" is treated on its own merits and its absolute deviation from the ideal path is determined in both magnitude and direction. This method incidentally leads at once to the well-known criterion "T" of Hartmann, which is now generally adopted in the comparison of large telescopes.

In the unavoidable absence of the Author, the paper was read by Prof. L. C. Martin, D.Sc., A.R.C.S., D.I.C., F.R.A.S.

In the discussion which followed, Dr. J. S. Anderson remarked on the importance of this paper in view of the labour involved in carrying out the Hartmann Test. After Prof. Martin had replied, votes of thanks were accorded to Mr. Kingslake for presenting the paper and to Prof. Martin for reading it.

There followed a demonstration of a Portable Stereoscopic Kaleidoscope by Dr. R. S. Clay and Sir Richard Paget. Dr. Clay, in showing the instrument, called attention to the fact that no new optical principles are made use of in this instrument. It differs from the ordinary Kaleidoscope mainly in the fact that the mirrors are of sufficient size to enable objects to be viwed by both eyes and thus to see them in stereoscopic relief. The mirrors are front silvered and are mounted at an angle of 30°, one mirror being vertical. The objects consisting of coloured silks, artificial flowers, etc., are arranged on a black velvet background on a drum, which is rotated at the open end of the mirrors, and lighted from one side by an incandescent lamp. The stereoscopic relief greatly adds to the charm of the resulting pictures.

Through the kindness of Messrs. C. Cussons Ltd., the Clarke Optical Smoke Box was demonstrated by the inventor, Mr. W. O. Clarke. This apparatus consists of a glass-fronted box which can be filled with smoke in which are placed lenses, mirrors, prisms, etc. An automatic clockwork arc lamp in conjunction with a series of stops passes a beam or beams, parallel, convergent or divergent through the box. The lenses, etc., can be placed singly or in combination in the paths of the beams, and their refracting and reflecting properties demonstrated to the audience. The main advantage is that with this apparatus the behaviour of a full beam incident on a complete lens or mirror can be shown. Among the experiments which were of special interest were the formation of caustics by spherical mirrors and lenses and the formation of spectra by a diffraction grating.

FORTHCOMING MINING EXAMINATIONS.

Examinations for First and Second Class Certificates of Competency as Managers and Under-Managers of Mines will be held on *May 23 and 24 at Edinburgh, Newcastle-upon Tyne*, Sheffield, Wigan, Cardiff and Birmingham.

The written part of an Examination for Certificates of Qualification as Surveyors of Mines will be held at the same centres on May 24.

Applications for the necessary forms should be made not later than April 11. In order that the appropriate forms may be sent it is important that candidates should state whether they have already sat at one of the Board's *Examinations*.

Letters should be addressed to the Secretary, Board for Mining Examinations, Mines Department, Dean Stanley Street, Millbank, London, S.W.1.

ANALYSIS OF COAL GAS.

In the usual methods adopted for the analysis of coal gas all those constituents which are absorbed by bromine or by concentrated sulphuric acid are designated "unsaturated hydrocarbons." These may *include aromatic* hydrocarbons, in addition to the olefines, diolefines, and acetylenes.

The separation determination of these is of particular interest, not only in the study of the influence of temperature upon the carbonisation products of coal, but from the point of view of the technical utilisation of certain of these products.

A Paper recently issued describes a method for determining the quantities of ethylene, propylene, butylene and butadiene in a sample of gas. A discussion of previous work on the subject and a bibliography are included.

BOARD OF TRADE ANNOUNCEMENT.

Safeguarding of Key Industries.

Representations have been made to the Board of Trade under Section 10 (5) of the Finance Act, 1926, regarding Lactic Acid which satisfies the requirements of the British Pharmacopœia, and Micrometers, including micrometer heads and micrometer measuring machines.

Any person desiring to communicate with the Board of Trade with respect to these representations should do so by letter addressed to the Principal Assistant Secretary, Industries and Manufactures Department, Board of Trade, Great George Street, S.W.1., within one month from the date of this notice.

ROYAL INSTITUTION.

A general meeting of the Members of the Royal Institution was held on March 5, Sir Arthur Keith, Treasurer and Vice-President, in the chair. The secretary announced the decease of Sir Dyce Duckworth and Mr. *Alexander Siemens, and resolutions of condolence* with the relatives were passed. Mrs. Dick, E. J. Glyn, L. V. Haigh, W. A. H. Harding, H. S. Harron, Mrs. C. D. Langworthy, P. de Laszlo, T. P. Legg, Dr. A. M. McCutcheon, P. E. Marrack, P. B. Moodie, J. G. P. Phillips, Mrs. M. I. M. Potter, Mrs. Riddel and J. W. Wilson were elected Members.

FORTHCOMING EVENTS.

THE ILLUMINATING ENGINEERING SOCIETY.

Tuesday, March 13,—"The Manufacture *and Properties of Glass and their Application* in Illuminating Engineering." By Dr. S. English.

INSTITUTE OF METALS.

London Local Section, at 83, Pall Mall, London, S.W.1.—Thursday, March 15, at 7.30 p.m.—"High Tensile Bronze." By Wesley Lambert.

Sheffield Local Section, at the University, St. George's Square.—Wednesday, March 14.—Electrical Engineering Lecture. Joint meeting with kindred societies.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

At the House of the Royal Society of Arts, John Street, Adelphi, London, W.C.2.

Tuesday, March 13, at 5.30 p.m.—"The Natural Gas of South Persia, Process Development and Exploitation." By Lieut.-Col. S. J. M. Auld, O.B.E., M.C., D.Sc., M.Inst.P.T.

PEOPLE'S LEAGUE OF HEALTH.

11, Chandos Place, London, W.1.

Wednesday, March 14, at 6 p.m.—" Mental Deficiency." By Dr. A. F. Tredgold, M.R.C.P.

Friday, February 16, at 6 p.m.—" Common Errors of Diet." By Prof. V. H. Mottram.

ROYAL INSTITUTION.

Albemarle Street, London.

Tuesday, March 13, at 5.15 p.m.—Prof. J. S. Huxley : "The Behaviour of Auimals."

Thursday, March 15, at 5.15 p.m.—Dr. J. J. Fox : " Optics and Chemistry."

Friday, March 16, at 9 p.m.—Prof. E. T. Whittaker : " The Quantum and Relativity Theories of Light."

Saturday, March 17, at 3 p.m.—Sir Ernest Rutherford : " The Transformation of Matter."

ROYAL INSTITUTE OF PUBLIC HEALTH.

37, Russell Square, London.

Wednesday, March 14, at 4.30 p.m.—" Bacteriology in its Connection with Forensic Medicine." By Robert Donaldson, M.A., M.D., Ed.

ROYAL SOCIETY OF ARTS.

Wednesday, March 14, at 8 p.m.—(Ordinary Meeting) . Harold G. Brown, M.I.E.E., of the D.P. Battery Co, Ltd., : " Lead Storage Batteries."

THE ROYAL SOCIETY.

Burlington House, London.

Thursday, March 15, at 4.30 p.m.—

UNIVERSITY COLLEGE.

Gower Street, London.

Monday, March 12, at 2 p.m.—"The Epic of England." A public lecture by Dr. C. J. Sirron. Also Foundation Play.

Tuesday, March 13.—Foundation Debate and Foundation play.

Wednesday, March 14. — International Concert.

Thursday, March 15. — Foundation Oration.

Friday, March 16.—Faculty of Laws. Second Term ends. Same date, Union Dinner.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Coutroller of His Majesty's Stationery Office.

Latest Patent Applications.

4.913.—Hereward, H. W.—Production of benzoic acid derivatives. February 16th.

4,799.—I. G. Farbenindustrie Akt.-Ges. —*Manufacture of stable solutions* of salts of stibinic acids. February 15th.

4,996.—Parkes, D. W.—Treatment of ammonia, etc., liquors. February 17th.

4,543.—I. G. Farbenindustrie Akt.-Ges. *Manufacture of indophenols.* February 13th.

5,189.—Gyorgy, K.—Apparatus for producing heat, etc., by chemical reactions. February 18th.

Specifications Published.

274,894.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of carboxylic acids of acenaphthelene.

282,814.—I. G. Farbenindustrie Akt.-Ges. —Manufacture and production of valuable liquid, and other hydrocarbons and derivatives thereof by the destructive hydrogenation of tars, mineral oils, resins, asphalts, and like initial materials.

Abstract Publisheu.

282,852.—Dyes.—British Dyestuffs Corporation, Ltd., Hexagon House, and Thornley, S., Crumpsall Vale Chemical Works, both in Blackley, Manchester.

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chloride, *o*-chlorobenzoyl chloride, *p*-nitro- and 3 :5-dinitro-benzoyl chloride *p*-benzoylbenzoyl chloride, α-naphthoyl chloride, and furfuroyl chloride. According to examples the condensation with hydroxylamine is effected in presence of ferrous sulphate and the product treated with benzoyl chloride in nitrobenzene and then with a solution of sodium hypochlorite which is finally acidified; the final product dyes cotton from the vat in brown shades.

p-Benzoylbenzoic acid chloride is obtained by treating the acid with thionyl chloride.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

OSTERMALT.

485,315.—Chemical substances, containing or prepared from malt, for use in medicine and pharmacy.—Joseph Nathan & Co., Ltd., 16, St. Helen's Place, London, E.C.3. February 22nd.

SOMNOSAL BRAND.

486,161.—Chemical substances prepared for use in medicine and pharmacy.——H. R. Napp, Limited, 3 & 4, Clements Inn, Kingsway, London, W.C.2. February 22nd.

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486,570.—Chemical substances prepared for use in medicine and pharmacy.—The Washington Chemical Company, Limited, Station Road, Washington Station, Durham. February 22nd.

OSSO.

486,481.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes, but not including poultry medicines, and not including any goods of a like kind to poultry medicines.—William Kennett Southgate, trading as W. K. Southgate 41a, Westgate Street, Ipswich. February 22nd.

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CONTENTS. PAGE.

Determination of e/m by American Physicists ... 161
By F. H. Loring.

General Notes:—
Trade from Fairs ... 166
Canadian Investments Abroad ... 167
A Manganese Deposit in Bannock County, Idaho ... 167

Proceedings & Notices of Societies:—
The Royal Society ... 169
Faraday Society ... 171
Institute of Metals ... 172
Society of Glass Technology ... 170
Geological Society ... 173

Forthcoming Events ... 175
New Patents ... 175
New Trade Marks ... 176

DR. W. ROSENHAIN, NEW PRESIDENT OF THE INSTITUTE OF METALS.

Dr. W. Rosenhain, F.R.S., has been Superintendent of the Metallurgy Department of the National Physical Laboratory, Teddington, since 1906. He is a graduate of the University of Melbourne, Australia, whence he came to England in 1892 under one of the Research Scholarships of the 1851 Exhibition Commissioners. He has carried out a large amount of metallurgical research both on non-ferrous metals and on iron and steel, and is also well known in connection with glass technology.

DETERMINATION OF e/m.

By F. H. LORING.

DETERMINATION OF e/m BY AMERICAN PHYSICISTS.

In America the work in this field has been more on the spectroscopic side, but in 1910 C .A. Proctor (*Phys. Rev.*, 1910, xxx, 58), using cathode rays had obtained the value 1.859×10^7, which is apparently too high, but no claim for high accuracy was made.

H. D. Babcock (*Astrophys. Journ.*, 1923, LVIII, 149), using the equation

$$e/m = (4\pi V/H).(\Delta\lambda/\lambda^2)$$

obtained the result below when,

H = intensity of the magnetic field.
$\Delta\lambda$ = separation of either n-components of a normal triplet of wave-length λ, from the undisturbed position of the line, this occurring in the phenomenon known as the Zeeman effect.
V = velocity of light in the medium in which $\Delta\lambda$ are measured. c is taken as 2.9986×10^{10} cm./sec. *in vacuo*, but corrected for the medium by using the index of refraction of Meggers and Peters (*Bull. Bureau of Standards, U.S.A.*, 1919, XIV, 731), *viz.*: 1.00028.

The range of values so obtained was from 1.7465 to 1.7946; but by weighting the values the mean result came out at 1.761×10^7 E.M.U.

R. T. Birge (*Phys. Rev.*, 1926, XXVIII, 848) had arrived at the value 1.7597×10^7 from spectroscopic formulæ, taking R_{inf} as 109737.3, c as 2.9986×10^{10} (now the older value), h as 6.557×10^{-27}, and e as 4.774×10^{-10}. Difficulties that appeared evident to the writer, in these calculations, were shown by attempts to co-ordinate the values (see *Chemical News*, 1927, CXXXIV, 193, 291, 321, 385; CXXXV, 17, 63, 67, 188, 325, 341). A method of adjustment was, however, arrived at finally.

W. V. Houston (*Phys. Rev.*, 1927, Nov. XXX, 608) has made a spectroscopic determination of e/m. This method being important, the following is taken from Houston's paper—the concluding part—being quoted in full except for the omission of Fig. 1. This work is of great interest and some re-calculations by the writer will follow.

" Throughout this work the relativity equation of Sommerfeld is assumed to apply exactly. This does not represent the neglect of the spinning electron theory or the new *wave mechanics, because these theories* together seem to give exactly the equation of Sommerfeld (Richter, *Proc. Nat. Acad.*, 1927, XIII, 426). Furthermore, the agreement of the Rydberg constant, computed by *this equation, from the first three lines of* the Balmer series, shows the very exact experimental applicability of this equation, apart from the various theoretical ways of deriving it (Houston, *Phys. Rev.*, 1927, XXIX, 748).

" To apply this equation, it is necessary to know the wave-lengths of the individual components of the fine structure. For this purpose the hydrogen line 6563 was examined *with the* compound interferometer (Houston, *Phys. Rev.*, 1927, XXIX, 478). Fig. 1 [not given here] shows a microphotometer curve from a plate taken with this instrument. The assymetry in the *shorter wave-length component is so pro*nounced that it is possible to determine the position of the third component which is causing it. This is the component predicted by the theory of Sommerfeld and Unsöld, and which has previously been inferred from the displacement of the maximum (Houston, *Astrophys. Journ.*, 1926, LXIV, 81). The assymetry has also been observed by Hausen (*Annalen*, 1925, LXXVIII, 558), and by Kent, Taylor, and Pearson (*Phys. Rev.*, 1927, XXX, 266). Because of this assymetry, only the long wave-length component is used in the computation of the Rydberg constant.

" However, although this long wave-length component appears symmetrical in the figure, the theory requires that it shall be multiple, and consist of one strong and *two weak components.* If we assume the distribution of intensities predicted, we can correct the position of the observed centre of gravity to the position of the strongest component. Table III gives the results of *this correction and the values of* R_H.

TABLE III.

λ (AIR).		ν (VAC.).		COR.		R_H.		
6562.8475	...	15233.0888	...	+ .0056	...	109677.754	±	.015
4861.3678	...	20564.6582	...	+ .0024	...	109677.775	±	.050
Giving the 1st a weight of 3 and the 2nd 1, mean =						109677.759	±	.008

The uncertainty in the individual values is equivalent to the mean deviation of the observed wave-lengths, while the uncertainty of the means is merely the mean deviation.

" In He 4686 the two strong components were identified with the components Ia and IIb. With this identification the values of R_{He} are given in Table IV.

TABLE IV.

λ (AIR).		ν (VAC.).		R_{He}		
4685.7030	...	21335.5622	...	109722.406	±	.028
4685.8030	...	21335.1070	...	109722.397	±	.061
			Mean =	109722.403	±	.004

The first value is given a weight of 2, the second a weight of 1.

" These mean derivations can hardly be taken as representing the precision of the values of R, and yet it seems reasonable to believe that, relative to each other, these values are correct within 0.020. Of course, the actual error from the correct value based on the cadmium standard is possihly larger, perhaps of the order of 0.050.

" The difference between this value of R_{He} and that given by Paschen is due to the fact that his value gave more weight to his component 4685.809 than to his component 4685.708 [this wave length is not of course to be confused with another one of 4685.307]. From these two Rydberg constants it is possible to determine the ratio of the mass of the electron to the mass of the nucleus. We have

$R_{He} = R_{int}/(1+m/m_{He})$, and .... (1)

$R_H = R_{int}/(1+m/m_H)$ .... (2)

where m is the mass of the electron and m_H and m_{He} are the masses of the hydrogen and helium nuclei respectively.

" *The atomic weight of helium is 4.0001* (Baxter and Starkweather, *Proc. Nat. Acad.*, 1926 XII, 699) from which m_{He} = 3.9990, and the atomic weight of hydrogen is 1.0077 (International Critical Tables, ...

from which $m_H = 1.0072$. In these units the mass of the electron is $m = 0.00054$. Using these values it can be shown that

$$m/m_H = (R_{He} - R_H)(m_{He} - m)/R_H(m_{He} - m_H) = 1.33648\ (R_{He} - R_H)/R_H \quad \ldots\ldots\ldots\ldots (3)$$

Then

$$e/m = (m_H/m)(F/m_H) \quad \ldots\ldots\ldots\ldots (4)$$

where F is the Faraday constant which is 96470 absolute amperes per gram molecule. With these values we have

$$e/m = (1.7606 \pm .0010) \times 10^7 \text{ E.M.U. per gram} \quad \ldots\ldots\ldots\ldots (5)$$

"This value agrees with that found by Babcock (*Astrophys. Journ.*, 1923 [see above]) from Zeeman effect measurements. However, the Zeeman effect method is subject to some criticism on account of the empirical nature of the Runge denominators.

"From R_H and m/m_H we have $R_{inf} = 109737.424 \pm .020$. from which, if $e = (4.774 \pm .005) \times 10^{-10}$, we have that $h = (6.557 \pm .008) \times 10^{-27}$. Most of this uncertainty in h is due to the uncertainty in e.

"The value of h gives the value of the fine structure constant $\alpha^2 = 5.307 \times 10^{-5}$, $\Delta\nu_H = 0.3638$ cm^{-1}.

"This precise determination of e/m, together with its close agreement with Dr. Babcock's value, makes this quantity the most accurately known factor in the Rydberg constant"—quotation ends here.

In the above quotation the writer has made a few trivial changes in the text which in no way alter the meaning. For example, in setting up equations by machine composition there appears to be no stock matrix for the inferior infinity sign and as a consequence a figure eight is laid down. This takes time and adds to the cost of setting up technical matter which renders scientific publication so expensive, and is a source of serious concern with societies and publishers generally. Now this can be obviated by using inferior letters if the printers have matrices for them, as in the case in point. Another disadvantage of built-up equations by hand setting is that the signs, letters, etc., are apt to get displaced, and the infinity sign might appear anywhere. These remarks would not apply if the cost of printing were not so great relative to the profits (if any) with scientific publications. The equations have been numbered for reference later.

It should be explained here that it is tacitly understood that the mass value of the electron given by Houston would not give a correct answer in the case of equations

Since it has been shown that Michelson's new determination of c (in his "Studies in Optics," 1927, p. 137, the vacuum value is given as 2.99796×10^{10} cms. per second, with a possible error of 1 in the last digit given), of much greater precision than hitherto, can be calculated by the equation (see Loring, *Chemical News*, 1928 cxxxvi, 33) :—

$$R_{inf}/(24 \times 10^{-33}/h) = c = 2.9979640\ldots \times 10^{10}$$

when $R_{inf} = 109737.\dot{3}\dot{7}$ and $h = 6.55\dot{6} \times 10^{-27}$, this suggests trying this value for R_{inf}, as it is in close agreement with Houston's value :— 109737.424; and, moreover, near to Birge's value (*Phys. Rev.*, 1926, xxviii, 848) :— 109737.3 ± 0.3.

Now F. W. Aston has quite recently redetermined a large number of atomic masses with a high degree of precision (see Aston : Bakerian Lecture, *Roy. Soc. Proc.*, 1927, A, cxv, 487; and also *Nature*, Dec. 31, 1927, p. 956), and he has arrived at the following valnes for H and He on the O = 16 basis :—

$$H = 1.0077_8. \quad He = 4.0021_6.$$

The last digit is uncertain according to Aston, which is indicated here by the inferior figures. It does not seem likely that Aston would have made the values any higher than necessary on account of the previous work by experienced experimentalists. The helium value (atomic weight) does not agree with the one by Baxter and Starkweather which was used by Houston (see citation above).

It should be noted, however, that Aston says : "The new instrument [mass spectrograph] has five times the resolving power of the old one, far more than sufficient to separate the mass lines of the heaviest element known. Its accuracy is 1 iu 10,000, which is just enough to give rough first order values of the divergences from whole numbers."

It will, nevertheless, be of interest to try Aston's values in connection with Houstou's spectroscopic findings. At the same time an adjustment is made in m to justify the slightly modified R_{inf} constant and Houston's R_{He} constant. Then $R_{He} = R_{inf}/(1 + m/m_{He}) = 109722.398424$, when

$$R_{inf} = 109737.\dot{3}\dot{7}.$$

$$m = 0.00054\dot{6}\dot{2}.$$

$$m_{He} = 4.00216 - (2 \times 0.00054\dot{6}\dot{2})$$

The value for m was adjusted by trial and error, but no claim for absolute accuracy can be made. In fact it is absurd to attempt 6th and 7th decimal places with precision, but the trial figure came out with a tendency to repeat. Probably the true value lies between 0.000545 and 0.000547. 0.0005457 was used by the present writer (see *Chemical News*, 1927), but this value seems a little low when adopting Aston's atomic weight values, especially in the case of He.

Now since the above equation for evaluating c seems as accurate as could be expected, it becomes possible to evaluate the writer's Δ_a with apparent precision, and it comes out at 0.015251652262... See *Chemical News* referred to above during the year 1927. Ot was shown that

$$\Delta_a^{-1} \times 10^{-28} = 10^{-28}/\Delta_a = h = 6.55\dot{6} \times 10^{-27}.$$

It was suspected that Δ_a taken n times (n being a whole number) might give the differences between the R constants. $982\Delta_a$ = 14.977122... This value subtracted from R_{int} above. gives 109722.396614..., which is in very close agreement with the calculated value above, the difference being 0.003190...; but, of course, this is not a proved case. It is merely an adjusted one based on the assumption of all the regulating constants involved agreeing closely with the best experimental values, or securing agreement therewith.

Carrying out the same procedure for R_H, using Aston's value for H, gives

$$R_H = R_{int}/(1+m/m_H) = 109677.891095,$$

when

$$R_{int} = 109737.\dot{3}\dot{7} \text{ (as before).}$$

$$m = 0.00054\dot{6}\dot{2} \text{ (as before).}$$

$$m_H = 1.00778 - 0.00054\dot{6}\dot{2}.$$

Now making a corresponding Δ_a calculation $39\Delta_a \times 10^2 = 59.4814438...$

$R_{int} - (39\Delta_a \times 10^2) = 109677.892293.$
Difference = 0.001197.

There is therefore a considerable departure from Houston's value for R_H, but the above calculated value is the same as the one obtained by H. Bell (*Phil. Mag.*, 1920, XL, 489) *viz.*: 109677.9, as based upon the very exact measurements of Paschen and of Curtis. It will be remembered that W. E. Curtis (*Roy. Soc. Proc.*, 1919, A, XCVI, 147) gave a range of calculations for R_H as follows: 109678.28; 109678.73; 109678.10; 109677.58; 109678.76; 109677.79, as worked out by the methods of different physicists. The last one due to H. S. Allen is nearest to the one above except for Bell's value which is in agreement. The first value in this set is the one due to Curtis, and this value has been taken by Fowler in his "Report on Series in Line Spectra," the edition being 1922.

These values are, however, narrowing down to a variation in the decimal region, and the above one by the writer as a result of these calculations cannot be said to be in serious error. There are certain features about the hydrogen lines that perhaps require further investigation, but this is more a matter for experienced workers to consider. Paschen's value was 109677.691 from which R_{int} was calculated as 109737.11. Now if the latter increases in the decimal region it is to be expected that the former might do so also, and this appears to be the case.

Now turning to equation 4, and using these new values, in which m_H/m = 1843.8635, the result here is

$$e/m = (m_H/m)(9647/m_H) = 17659995.$$

This is, of course, practically

1.7660×10^7 E.M.U. per gram.

This value agrees fairly well with the European continental physicists' value given in the first part. In fact it is a somewhat better comparison to make as Babcock's value was a mean of determinations that showed a very wide range of variation, though this fact of variation might apply more or less generally — but the word *somewhat* qualifies the statement sufficiently.

In the concluding lines of Houston's important paper, mention is made of evaluating $\Delta\nu_H$. Now $\Delta\nu_H$ is in one sense a variable quantity, but it appears to the writer that in the equation, as in Sommerfeld's book, the evaluation of this constant from e, h, etc., really means that a *limiting* value is obtained. Such a value would, of course, be higher than those observed in the case of the usual hydrogen doublets, and the writer evaluated a *numerical* quantity designated Δ_H, which by virtue of the multiplier 24 (see equation for the velocity of light above)

comes out at 0.86603965429..., which is $24\Delta_s$. Kent, Taylor and Pearson (*Phys. Rev.*, 1927, xxx, 266) have redetermined the doublet separations, and in terms of ν obtain $\Delta\nu = 0.323$ cm^{-1} for Hα line; the Hβ line has a value of 0.350, and Hγ line a value of 0.357. These determinations are, by the way, in close agreement with those of Houston, measured previously.

This led to another method of determining e/m. The writer found that certain agreements in the various relations described in the *Chemical News*, 1927, involving Δ_H, could be brought into harmony by introducing a correcting term in certain equations in which π occurred, and it was concluded that it would be worth while considering a modified π called π_s. This obviated the use of a higher R_{inf} than seemed possible. In other words R_{inf} as below could be used, and it was finally found that e/m could apparently be calculated thus :—

$e/m = (\pi - \pi_s)c/\sqrt{[(\pi^2 - \pi_s^2) \times 10^3]} =$ 17665515.

$\pi^2 = 9.8696044011.$

$\pi_s = \sqrt{\{\pi^2/[(R_{inf} + \Delta_s \times 10^4)/R_{inf}]\}} =$ 3.1394117834.

$c = 29979640853$. cms. per sec. *in vacuo*.*

$\Delta_s = 0.015251652262...$

$R_{inf} = 109737.\dot{3}\dot{7}$ (as before).

* Calculated from the equation for evaluating c given earlier in this paper.

It was noticed, also, that by using one of Euler's numbers, $E_6 = 0.2702765 \times 10^7$ the above equation could be modified thus : $(\pi - \pi_s)c/(10^7/E_6) = e/m = 17671155.$

CONCLUDING REMARKS.

Arranging all the more probable values of this paper in the order of increasing magnitude gives the following range :—

17606000
17659995
17665515
17671155
17674000
17674961

It does not seem possible to arrive at any definite conclusion, but **1.767 x 10⁷** would seem a fair value to take, pending further information, especially for the e/m_0 value.

It is of interest to note the possible revised Rydberg constants as follows :—

$R_{inf} = 109737.\dot{3}\dot{7}$
$R_{He} = 109722.396$
$R_H = 109677.892$

A remark about chance coincidences will not be out of place here. While there seems a marked generality in close agreement there is the danger of one or two extraordinary chance coincidences, and therefore it is necessary perhaps to suspend judgment.

New methods have, however, been worked out and with new determinations and closer calculation with appropriate adjustments it should be possible to narrow the values of the constants down to a variation in the third decimal place in the case of the R constants, while the e/m value may be reduced to a minimum in the fifth decimal place as usually expressed.

There may be an appreciable variation between the rest-mass value and the one obtained with spectroscopic constants, and it seems probable that the above group of six values just about represents such a variation. Notwithstanding the strange nature of the first equation above with π_s in it, the writer is inclined to suspect the value 17665515 as the true one for the spectroscopic value of e/m in E.M.C.G.S. units.

Using Houston's equation 3, with the revised values, substantially the same result as above is obtained, *viz.* : 1.7662410, which makes the all-round agreement better (diff. of 0.00024...), this being the object sought here. This seems to show that the relativity change in mass is less than Houston's original figures would imply.

GENERAL NOTES.

IMPERIAL CHEMICAL INDUSTRIES LIMITED.

The offer made on February 15 to the shareholders of the Tees Salt Company Limited to exchange their shares for shares of Imperial Chemical Industries Limited has been accepted by holders of over 75 per cent. of each class of capital of the former Company, and transfers for the carrying out of the exchange are being issued.

TRADE FROM FAIRS.

Lord Strathspey writes :— "British industry has achieved so noteworthy a victory at our record Fair that I may be pardoned for suggesting that we might look to Europe and overseas for other fields to conquer.

If business men from abroad have found it profitable to visit our Fair, might our own business men not find it equally profitable to mingle in the Fairs of other lands? Yet I find that last year the number of British business men who thought it worth while to see the Swiss Industries Fair at Basle was just—eleven! We were the sixth country in their visiting list, France leading with 679 commercial ambassadors and Germany coming a close second with 666. His Lordship thinks that sorry record ought to be improved upon when the Basle Fair once again opens its doors next month from April 14-24. Switzerland is a prosperous country with a large demand for the textiles, machinery and so on that we could give her; nevertheless I find that, while she does purchase more cotton goods from us than from any of her neighbours, we are beaten in woollen goods by France and Germany; by these countries and by the United States and Italy in machinery."

THE ELECTRON.

On Saturday, March 3, Prof. Sir J. J. Thomson, Master of Trinity College, Cambridge, delivered the first of the Founders' Memorial Lectures at Girton College. He described how recent experiments, especially those made by Professor G. P. Thomson on the passage of electrons through very thin films of metal had thrown quite a new light on the nature of the electron. They had proved that a uniformly moving electron was accompanied by a train of waves which preceded and guided it, the electron following in the wake of the waves. The electron had thus, like light, a dual structure; one part, that containing the energy, was corpuscular; the other, the part controlling and guiding the path, was undulatory. The waves which accompanied the electron vibrated far more rapidly than the hardest Röntgen rays; the only rays approaching them in this respect were the γ rays from radio-active substances. The vibrations were quicker when the electron moved fast than when it moved slowly, but however slowly it might move, the waves never made fewer than a very large number of vibrations per second. Short as these waves were, their lengths were more than 10,000 times the diameter usually ascribed to the electron.

These results showed that the early conception of the electron as a point-charge of negative electricity surrounded by a structureless medium could not be adequate; the electron or its surroundings must be much more complex; there must be something beyond the electron. If, however, they supposed that the electron did not represent the final stage in the structure of matter, but that it was itself composed of, or surrounded by, something which might be regarded as a mixture of sub-electrons and sub-protons, it might be shown that its properties would resemble those which it had lately been shown to possess. Through such surroundings energy would be accompanied and guided by waves, and the connection between the speed with which the energy moves and the wave-length of the waves would be the same as that found in Professor G. P. Thomson's experiments.

An example on a cosmical scale of a structure analogous to that assumed for the electron and its surroundings was the Heaviside layer in the upper region of the atmosphere, where free electrons and protons were mixed with the ether. Through that layer energy could travel at any speed less than that of light if accompanied and guided by suitable waves, all of which were of high pitch. The consequences of that theory, which was founded on purely physical considerations, agreed in a remarkable way with the consequences of the very interesting wave dynamics due originally to Louis de Broglie and extended by Schrödinger and others.

CANADIAN TALC AND SOAPSTONE INDUSTRY SHOWS PROGRESS.

The production of talc and soapstone in Canada in 1926 totalled 15.767 tons, valued at $217,195. These figures represent an increase of 1,293 tons and $11,360 over 1925. The first six months of 1927 show a slight decline of 159 tons and $3,707 over the corresponding period of 1926.

The bulk of the ground talc produced in Canada continues to come from the Madoc district, Hastings County, Ontario, where important deposits of superfine, foliated, white talc have been worked for over twenty years. The Madoc output is ground in local mills, and finds employment in the talcum powder, paper, textile, soap, and rubber industries. Domestic consumption is small; the greater part of the production being exported.

DYESTUFFS (IMPORT REGULATION) ACT, 1920.

APPLICATIONS FOR LICENCES IN FEBRUARY, 1928.

The total number of applications received during the month was 659, of which 540 were from merchants or importers. To these should be added 21 cases outstanding on the 31 January, making a total for the month of 680.

ONTARIO GOVERNMENT TO SET UP RESEARCH FOUNDATION.

At the opening of the Legislative Assembly of Ontario at Toronto, intimation was given that the Provincial Government proposed to ask authority to make a contribution towards the establishment of a Research Foundation in Ontario. A sum of $2,000,000 is to be raised in five equal annual instalments. Of the amount stated, manufacturing interests in the Province, through the medium of the Canadian Manufacturers' Association, are expected to provide one-half and the Provincial Government will make up the balance, contributing dollar for dollar.

The type of research to be engaged in will have particular reference to the development of natural resources within the Province. A portion of the fund, it is expected, will be devoted to the solution of problems connected with production and processing.

CANADIAN INVESTMENTS ABROAD.

According to the Toronto *Financial Post*, of February 3, Canadians have during the past few years since the War increased their foreign investments to a remarkable extent.

Such investments include bank balances in London, New York, and elsewhere, railway lines in the United States ,investments in foreign securities by banks, insurance and other companies, and similar investments by private individuals.

The *Post* estimates that on January 1, 1928, the aggregate of Canadian investments abroad had reached $1,362,400,000, of which $118,000,000 was invested in the United Kingdom, $722,200,000 in the United States, and $522,200,000 in other countries.

Interest and dividend receipts in 1926 from Canadian investments abroad have been estimated to reach $68,000,000, divided as follows: from the United Kingdom, $6,000,000; from the United States, $34,000,000; and from other countries $23,000,000.

CANADIAN MATCH-MAKING INDUSTRY CENTRED AT PEMBROKE, ONTARIO.

The amalgamation of all of the concerns in Canada engaged in the manufacture of matches has now been completed by the organisation of the new Eddy Match Company, the shareholders of which have met to elect its directors and officers. Mr. A. G. Woodruff, of Pembroke, Vice-President and General Manager of the new concern, announced that the Bryant and May interests of Great Britain and the Diamond Match Company of the United States, have acquired a controlling interest in the company, which will embrace in its holdings the match-making plant formerly operated by the . B. Eddy Company, Ltd., at Hull, Quebec, and the plant hitherto operated by the Canadian Match Company, Ltd., and the World Match Company, Ltd., at Berthierville, Que. The head office will be at Pembroke, Ont.

A MANGANESE DEPOSIT OF PLEISTOCENE AGE IN BANNOCK COUNTY, IDAHO.

By D. F. HEWETT, U.S.A. Geological Survey.

SITUATION AND ACCESSIBILITY.

The deposits thus far known in the region lie along the west slope of the ridge east of Bear River, about 1 mile south-east of Cleveland, Bannock County, Idaho. The principal deposit, operated by the Idaho Manganese Co., is in the E ½ sec. 31, T.11 S., R 40 E., and others lie farther south in sec. 6, T. 12 S., R. 40 E. The ore that has been shipped thus far has been hauled in motor trucks either to Gr ace, 14 miles north, on a branch of the Oregon Short Line, or to Oxford, 20 miles west, on the main line of the Oregon Short Line running from Ogden to Pocatello. The cost of hauling to Grace is $3 a ton, and the freight rate from Grace to Ironton, Utah, where most of the ore has been sold, is $2 a ton. The area lies within the Preston quadrangle, which is covered by the topographical map published by the United States Geological Survey.

History.

According to the local operators, float manganese minerals were found in this region in April, 1922, by Sam Ames on the property of the Cleveland Mining Co., a part of the W. C. McGregor ranch. In April, 1924, explorations showed the presence of another deposit half a mile north, and this has since been explored almost continuously by the Idaho Manganese Co., of which Nathan Smith, of Cleveland, is president.

Recent explorations south of the McGregor ranch have shown the presence of sporadic manganese minerals, but no ore has yet been shipped.

General Geology.

Bear River rises east of the Wasatch Mountains in north-eastern Utah, flows north into south-western Wyoming, then north-east into south-eastern Idaho, and finally south into Salt Lake in Utah. Along its course are several broad valleys separated by constricted valleys or canyons. Gentile Valley, in south-eastern Idaho, is one of these broad valleys. At its south end is the settlement of Cleveland, near the point where Bear River, flowing south, enters a narrow canyon. Twelve miles south of Cleveland the canyon ends and the river enters Cache Valley, one of the large open valleys of northern Utah. East of Gentile and Cache Valleys lie the Wasatch Range and its minor ridges and spurs.

The geology of the region was studied in a reconnaissance manner as early as 1872, and it is within the area of the geologic map prepared by Peale in 1877. Briefly stated, Peale recognised that the higher mountains, such as the Wasatch Range, were made up of a thick section of Paleozoic and Mesozoic rocks that were greatly deformed and faulted in early Tertiary time, after which erosion and minor faulting produced ranges and ridges much as they appear to-day, except that the valleys were deeper and the mountains relatively higher. In late Tertiary time (Pliocene?) a few areas, several of which are exposed in upper Bear River Valley, received sand and gravel, in part of local origin and in part from remote sources. Similar beds, nearly horizontal, cover the divide between Gentile Valley and Cache Valley. During early Pleistocene time each valley contained a lake that received sediments from the bordering ridges to a maximum altitude of 5,800 feet. Terraces at lower levels were also noted—at 5,526 feet, 5,185 feet (Lake Bonneville stage), and 5,526 feet is well shown on both sides of the southern part of Gentile Valley, and the manganese deposits that are described herein occur in the horizontally bedded fine sand, 100 to 150 feet below this terrace.

In 1883 Gilbert made rather exhaustive physiographic studies of the Lake Bonneville basin, on the basis of which he threw doubt on the existence of a short terrace at 5,800 feet, reported by Peale, and concluded that although there are terraces existing in Gentile Valley above 5,200 feet they were formed by rivers instead of lakes.

Although the writer's visit in this region was brief and necessarily devoted largely to an examination of the manganese deposits, it yielded observations which indicate that the ridges on both sides of Gentile Valley are covered with a veneer of horizontally bedded fine sediment up to a uniform altitude of about 5,500 feet and that this was deposited along the borders of a lake that was in existence in early Pleistocene time, before Lake Bonneville, farther south, stood at an altitude of 5,200 feet.

The Manganese Deposits.

Workings.—The workings on the tract of the Idaho Manganese Co. include three tunnels—the highest, 75 feet long, at an altiture of about 5,440 feet; the intermediate, 75 feet long, at an altitude of about 5,432 feet; and the lowest, 225 feet long, at an altitude of 5,375 feet. These tunnels explore the beds that underlie the terrace, the top of which ranges locally from 5,475 to 5,500 feet. The floor of Bear River valley near by lies at an altitude of about 4,900 feet. On the property of the Cleveland Manganese Co., half a mile to the south, there is a tunnel 90 feet long at an altitude of 5,250 feet.

The highest tunnel of the Idaho Manganese Co. explores a poorly defined zone of impure, earthy brown wad, 2 to 3 feet thick, which overlies thinly laminated fine sands. Unlike the zone explosed in the lowest tunnel, it contains no nodules of hard pure oxides of manganese. The zone is of doubtful value as a source of manganese and is interesting largely because it shown the presence of more than a single manganiferous zone.

The intermediate tunnel extends 20 feet to the top of a shaft, and a drift 75 feet long to the north-west explores an irregular zone of soft wad in which there are sporadic hard nodules of manganese oxides. With the upper part of the shaft, these workings

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.

The following papers were read at the meeting held on February 16 :—

The Arc Spectrum of Carbon. By A. Fowler, F.R.S., and E. W. H. Selwyn.

Further observations of the arc spectrum of carbon (CI) have been made, and the classification of the lines has been considerably extended. The deepest term is a triplet P_0, the value of which is estimated as 90107, corresponding to an ionisation potential of 11.2 volts. Comparisons are made with the spectra N II and O III, the atoms of which are similarly constituted but differ in nuclear charge.

The Chemical Constant of Hydrogen Vapour and the Failure of Nernst's Heat Theorem. By R. H. Fowler, F.R.S.

Dennison's theory of the specific heat of H_2 requires that at ordinary and low temperatures H_2 should behave as a non-combining mixture of two different sorts of molecules, the symmetrical and the anti-symmetrical, in the proportion of 1 to 3. The consequences of this theory (which must be accepted) are here followed up, and it is shown that the observed constant in the vapour pressure equation for H_2 will be given by the theory but only if liquid and solid H_2 are equally mixtures of the two non-combining molecules in the same proportion. It then follows that the weight of the lowest state of solid H_2 cannot have the value 1, so that on the usual convections the entropy of solid H_2 remains positive at the absolute zero. The bearing of this on Eucken's work and apparent failures of Nernst's Heat theorem is discussed.

The Ionised Hydrogen Molecule. By A. H. Wilson. Communicated by R. H. Fowler, F.R.S.

Schrödinger's method is applied to the quantisation of a molecular system consisting of one electron and two protons. The resulting differential equations are just those dealt with in a paper on "A Generalised Spheroidal Wave Equation." It is found that if wave functions which are bounded in the whole of three dimensional space are used, the system admits of no stationary states. An attempt is made to overcome this difficulty by employing a wave function which becomes infinite at the two nuclei and along the line joining them, but which otherwise is regular. With such a wave function, stationary states exist for all distances apart of the nuclei. Formulæ are given for the calculation of the energy of the lowest state, and the minimum value of this for different nuclear separations gives the energy of the ion H_2^+. The final calculations have not been carried out fully but some rough values are in agreement with those obtained by Burran, which lead to the experimental result. No attempt is made to explain the physical significance of unbounded wave functions.

A Generalised Spheroidal Wave Equation. By A. H. Wilson. Communicated by R. H. Fowler, F.R.S.

The equation is a second-order differential equation with three real singular points, two regular and the third irregular. The equation contains three independent parameters, and in this respect differs from the spheroidal wave equation which only has two. There are many types of solutions, but only two are of importance.

The first class consists of those functions which are bounded in the real interval joining the two regular singularities. To obtain these functions it is necessary to impose one relation on the parameters. This relation is expressed by means of an infinite continued fraction. The second solution and linear combinations of the two are also of importance.

The second class of functions consists of those bounded in the real interval joining a regular singularity to the irregular point. As the functions will have this latter point as an essentially singular point, it is necessary to define the method of approach.

Such solutions can only be obtained by imposing two algebraic relations on the three parameters. In this case the solutions can be expressed in terms of elementary functions, and form a denumerable set. Various asymptotic formulæ are given, suitable for large values of variables or of parameters. The ordinary spheroidal wave equation is also treated and the solution obtained in a form suitable for physical applications.

The Heating Effects of Thorium and Radium Products. By S. W. Watson and M. C. Henderson. Communicated by Sir Ernest Rutherford, P.R.S.

Recent determinations of the rate (Z) of emission of alpha-particles by radium differ by 10 per cent.; Hess and Lawson give 3.72×10^{10} alpha-particles per gram per second, while Geiger and Kerner give 3.40×10^{10}, the former value agreeing well with

radon. In order to obtain further evidence as to whether it is justifiable to calculate rate of emission of alpha-particles from heat-particles from heating effect, the authors have measured the rate heat of liberation by five *different products, viz.*, radon + Ra(A+B+C), Ra(B+C), RaC, Th(B+C), and *ThC*.

A resistance thermometer method was employed, the calorimeter wall having an absorbing thickness equivalent to 0.7 mm. of aluminium. Using the known rate of emission of alpha-particles by ThC relative to RaC, the ratio of observed to calculated heating is found to be constant within experimental error for all five products, and to agree well with Hess and Lawson's value of Z. The discrepancy in the worst case, *viz.*, Th(B + C), is 2 per cent.

If Geiger and Werner's value of Z be correct, the excess heat over and above that provided by the known radiations must be a nearly constant fraction of the whole (9 to 12 per cent.) for all the substances investigated. It must also be in a form easily absorbed by 0.7 mm. of aluminium, and if electromagnetic would require about 40 quanta at least per atom disintegrating.

THE SOCIETY OF GLASS TECHNOLOGY.

At the meeting of the Society of Glass Technology held in Sheffield on February 18, 1928, two papers were presented and discussed.

Note on the Ultra-Violet Ray Transmission of Colourless Bottle Glass. By DAVID STARKIN, M.Sc., AND PROF. W. E. S. TURNER.

Curves showing the intensity of the light transmitted in the different parts of the spectrum, from wave length 6500A down to the limits in the ultra-violet, for eight commercial soda-lime-silica glasses of very similar composition, were prepared. Each glass showed a maximum transmission in the green or yellow regions, the percentage of light transmitted then falling off gradually in the violet and near ultra-violet regions until a wave-length of about 3300A was reached, when the percentage of light fell off very rapidly to the limit of transmission. The glass containing 0.05 Fe_2O_3 transmitted down as far as wave-length 2960A. Four others each containing 0.07 per cent. Fe_2O_3 transmitted down to 2995A, whilst the pale green glass with 0.18 per cent Fe_2O_3 had its [illegible] 3175A. All the glasses, with the exception of the green one, transmitted further down into the ultra-violet than the average window glass, the limit for this being at about wave-length 3100A.

As further illustrating the relation between transmission in the ultra violet and iron oxide content ,some pure glasses, of approximate composition 75 per cent. SiO_2, 10 per cent CaO, 15 per cent. Na_2O, containing small amounts of iron oxide, were tested. The iron oxide content and the limits of transmission were :—

0.005 per cent.	Fe_2O_3	transmission	to		2600A.
0.008 ,,	,,	,,		,,	2660A
0.015 ,,	,,	,,		,,	2740A

The Analysis of Opal Glass. By W. SINGLETON B.Sc., AND R. C. CHIRNAIDE. (General Electric Co., Ltd., Research Laboratories).

The constituents commonly occurring in commercial, fluoride glasses were dealt with briefly, but more detailed consideration was given to the determination of boron, zirconium, tin, zinc, and arsenic.

Silica was determined by the method of Berzelius, lead was separated as sulphide, converted to sulphate, and finally determined by the volumetric method, as molybdate. Iron oxide and alumina were separated by means of ammonia in slight excess, while lime was precipitated as oxalate, then ignited and weighed finally as calcium sulphate. Magnesia was determined in the usual way, being weighed as the pyrophosphate.

The recently published volumetric method of Cone and Cady for the determination of zinc after separation as sulphide, was described fully. The authors had found that fluorine present in a glass to the extent of some 5 per cent. did not interfere with the determination of boric oxide by the method of Wherry, as modified by J. D. Cauwood and T. E. Wilson.

Zirconium was determined as pyrophosphate, according to the method described by W. F. Hillebrand.

Arsenic was determined after decomposition of the glass by means of hydrofluoric acid. The solution of the glass was neutralised by ammonia, made acid with hydrochloric acid, then the arsenic was precipitated as sulphide. This was filtered, dissolved in caustic potash solution, and the arsenic finally determined volumetrically by titration against standard iodine solution.

Fluorine was determined as calcium fluoride in the usual way, and no difficulties had been met in the determination of tin by the usual gravimetric methods.

THE DISSOCIATION OF SODIUM SULPHATE DECAHYDRATE.

By Edgar Philip Perman and William Donald Urry.

(University College, Dublin.)

(*Before the Faraday Society, February 29, 1928.*)

Part I. Dissociation Pressure.

The dissociation pressure of salt hydrates has been studied by many investigators, but attention has been concentrated so far chiefly on methods of measurement rather than on obtaining complete data or on theoretical considerations.

The following work has been carried out with the object of investigating the free energy change associated with the formation of a salt hydrate over as wide a range as permitted by the stability of the compound. Sodium sulphate is well suited to this purpose. The dissociation pressure of the system decahydrate — anhydrous salt — vapour is high compared with that of other salt hydrate systems, and there is only one stable hydrate.

Schottky has investigated some cases of this type, making thermal measurements as well as those of dissociation pressure, but the agreement between the two sets of results is not very close.

Bonnell and Jones give a resumé of the methods used by numerous investigators. Our method was very similar to that of Bonnell and Jones, but was arrived at as a slight modification of that used by Downes and Perman, the bubblers in the thermostat being replaced by a saturator containing the two forms of sodium sulphate. The saturator was made of two glass cylinders 29 cm. long and 4 cm. in diameter, connected at one end by a narrow glass tube; they were fixed in a horizontal position in the thermostat. The incoming air passed first through a drying and purifying train outside the thermostat, consisting of tubes containing soda-lime, lead acetate, and concentrated sulphuric acid respectively; it then passed through a narrow thin-walled tube (in the thermostat) containing copper turnings, to enable the air to take the temperature of the thermostat, and next into one end of the saturator. Coming out of the other end it passed through the 3-way mercury tap (see Downes and Perman).

A saturator of different design was used in some of the experiments; it was 90 cm. in length and 1 cm. in diameter, but had a series of bulbs 2 cm. in diameter and 3 cm. apart. The two forms gave equally consistent results.

The mode of experiment was the same as described by Downes and Perman except that the rate of aspiration was reduced to about one litre in 6 hours.

Part II. Heat of Hydration.

The heats of hydration of sodium sulphate have been determined at four temperatures between 20° C., and 30° C. As the work was carried out in the summer months of 1926, it was found impossible to work accurately at lower temperatures. The method of measuring the heat changes was identical with that used by Harrison and Perman. When measuring the heat of solution, the salt weighed in a thin walled tube was introduced into the water in the Dewar flask by pushing a glass plunger through the bottom of the tube. The following measurements were made :—

(*a*) The Heat of solution (including the Heat of dilution) of 2.84 g. Na_2SO_4 in 600.0 g. water.

(*b*) The Heat of solution (including the Heat of dilution) of 6.44 g. Na_2SO_4 less the heat of solution of 1/50 MNa_2SO_4. 10 H_2O in 596.4 g water.

The total quantity of water was the same in the two experiments and since the saturated solutions were identical, the heat of dilution was the same in each case. Heat effect (*a*) - heat effect (*b*) gives the heat of solution of 1/50 mol. $Na_2SO_4.10H_2O$, *i.e.*, 1/50 of the heat of hydration. Owing to the large quantity of water used (600 g.) and the small quantity of salt (2.84 g. Na_2SO_4), it was assumed that the volnme change was negligible.

The Application of the Nernst Heat Theorem to the Dissociation of a Salt Hydrate.

Let A = the free energy change, Q = the heat of reaction at constant volume (identical with the change in the internal or total energy), and Q^0 = Q at absolute zero.

Then Nernst's theory requires that

$$A = Q_0 - bT^2 - \frac{cT^3}{2} - \quad \ldots\ldots\ldots\ldots(1)$$

$$Q = Q_0 + bT^2 + cT^3 \quad \ldots\ldots\ldots\ldots\ldots\ldots(2)$$

These equations apply strictly only to solid systems, for they are based on the essential point of Nernst's theory, *viz.*, that as the absolute temperature is approached dA/dT approaches dQ/dT and becomes identical with it at temperatures near absolute zero. At these temperatures no liquid or gas can exist, and the test must there-

fore be made with quantities relating to the solid system only : Sodium sulphate—Ice—Sodium sulphate decahydrate.

In order to determine b it was more convenient to obtain a series of heats of hydration than to measure the specific heats of the participants, as is usually done. Such measurements of heats of hydration were therefore made and compared with heats calculated from values of A given in Part I., and the use of the equations (1) and (2).

Having found Q_0 and b in the equation $A = Q_0 - bT^2$; by substituting in the equation $Q = Q_0 + bT^2$ we obtain a value of Q at a given temperature T° absolute. The heats of hydration have been measured at temperatures from 22.4° to 29.9° C. Taking the free energy change at 22.50° C. = 2680 cals. per 10 mols., and at 25.00° C. = 2670 cals., we get

$$A = 3269 - .00674T^2$$
$$Q = 3269 + .00674T^2.$$

THE CHEMICAL CONSTANT OF WATER VAPOUR.

Nernst has extended the application of his theorem to the case when vapour co-exists with any number of solid bodies. We then have

$$\log_{10}K = -\frac{Q_0}{4.57T} + \Sigma n\ 1.75$$

$$\log_{10}T + \frac{bT}{4.57} + \Sigma nC,$$

where K is the reaction constant at constant pressure, Q_0 and b having the same meaning as before.

ΣnC = the algebraical sum of the chemical constants of the participants. The determination of the coefficient of T without an accurate knowledge of specific heats is uncertain, but the equation gives but slightly different results when this term is excluded.

Considering the dissociation of a hydrate yielding vapour and anhydrous salt, $\log_{10}K = \log_{10}\pi\pi$ where $\pi\pi$ is measured in atmospheres. ΣnC is the chemical constant of one mol. of water vapour; Q_0 is obtained from the equation connecting dissociation pressure (in atmospheres) and heat of dissociation (Part I.).

Then

$$C = \frac{12991}{4.57T} + \log_{10}\pi - 1.75\log_{10}T.$$

THE INSTITUTE OF METALS.

TWENTIETH ANNUAL GENERAL MEETING.

At the twentieth Annual General Meeting of the Institute of Metals, held in London on March 7 and 8, 1928, the retiring President, Sir John Dewrance, K.B.E., presented the Report of Council for the past year.

The Report, of which the following is a summary, stated that " the Council feels that the members can congratulate themselves upon the continued progress of their organisation." The Institute has increased in status in membership, in financial resources, and also in the extent of its library and office accommodation.

The membership has increased during the year from 1801 to 1903.

The council has under consideration the desirability of arranging further foreign meetings, and a committee has been appointed to explore this matter.

Steps taken by the council to secure more practical papers are mentioned in the Report, and reference is made to the progress of the Institute's Journal.

The six local sections of the Institute continued their good work during the year. A notable feature of the meetings of these sections was that many were held jointly with other kindred societies. In accordance with the new Article of Association, the council, for the first time, exercised its power to co-operate a Chairman of a Local Section as a Member of Council the choice falling upon Mr. A. H. Mundey, Chairman of the London Local Section.

The council direct attention to the extent to which the Institute's membership has now become world wide. Whereas ten years ago, our of a total membership of 888 only 200 resided Overseas (in 25 countries), the 192 total of 1903 members including 700 Overseas members resident in 41 countries. It is gratifying to note that the Institute's work is so widely appreciated, and the Council is glad to encourage this interest on the part of the Overseas membership.

The rapid growth in its Overseas membership shows the extent to which those at a distance, and not in a position to participate in the Institute's activities, value its work.

It is hoped to raise the membership to 2,000 during the present year.

The work of the Corrosion Research Committee is fully dealt with in the Report. A programme of work with the new appara-

tus for large-scale laboratory tests was started at the beginning of the year, and has been proceeded with continuously. The tubes tested include various types of 70 : 30 brass and Admiralty alloy tubes, several compositions of cupro-nickel, and a few special alloy tubes. During the year a number of cases in connection with condensers of ships and power stations have been investigated, and have given interesting information.

The council is glad to be able to report that during the year it was found possible to carry out a scheme that has been projected for many years—but hitherto rendered impracticable owing to lack of funds—whereby the library might be enlarged and a full-time trained librarian appointed. The new Library, which is well stocked with up-to-date metallurgical books and periodicals, has been placed under the charge of Miss E. B. Wynburne, B.A. It is hoped that the new arrangement, together with the provision of a telephone in the the Reading Room, will enable still greater service to be afforded to members. Certain books that are not contained in the library can now be obtained on loan for the use of members from the Science Museum at South Kensington. This is a most valuable new facility. Members are reminded that they can borrow books or periodicals from the library by post. The full development of the library is still hampered by lack of funds, and the council would welcome donations to the to the library fund or the gift of books.

The council reports that the long needed expansions of the Institute's office accommodation was possible during the year, an adjacent suite of rooms on two floors having become vacant. Thus the accommodation has been more than doubled. Illustrations issued with the report indicate how conveniently the Institute is now housed.

On the financial side it is recorded that the year's income of £7,256 compares with an expenditure of £6,710 over the same period. The balance of £546—higher than for some years past—is regarded as encouraging. It is largely the result of an increase in subscriptions and Journal sales, which increase has more than kept pace with the growing cost of the Journal, whilst the management expenses have remained the same as last year. Subscriptions and Entrance Fees brought in the sum of £5,781 as compared with £5,835 a year previously. The Journal sales amounted to £1,215—another record figure—the corresponding total being £1,128 last year. The treasurer justifies the large expenditure of £3,256 (compared with £2,809 last year on the Journal in the following words : " The fact must be recognised that the Institute lives by its Journal. Without a Journal or the high standing that ours has attained, our large Overseas membership would not exist and our home membership would not be but a mere fraction of its present total, whilst posterity would have no means of assessing the value of the communications that are discussed at meetings of the Institute."

In conclusion, the treasurer says " it is felt that the members can congratulate themselves upon the financial position of the Institute. In spite of certain increases of expenditure, and as a result of many economies in various directions, the Institute's resources have been strengthened to the extent of over £500 during the year.

GEOLOGICAL SOCIETY OF LONDON.

The Annual General Meeting was held on February 17, 1928, Dr. F. A. Bather, M.A., F.R.S, President, being in the chair.

The Reports of the Council and the Library Committee, proofs of which had been previously distributed, were taken as read. The Reports stated that, of the 42 Fellows elected in 1927 (4 less than in 1926), 28 paid their Admission Fees before the end of tbat year, making, with 17 previously elected Fellows and 2 reinstated Fellows, a total accession of 4 in the course of 1927. During the same period, the losses by death, resignation, and removal amounted to 45, and there was thus an increase of 2 in the number of Fellows (as compared with a decrease of 3 in 1926).

The Receipts of the year, including the interest on the Sorby and Hudleston Bequests and £105 11s. 3d. transferred from the Barlow-Jameson Fund and the Prestwich Fund, and a grant of £400 made by the Royal Society, amounted to £4,714 1s. 3d. The total Expenditure of the Society amounted to £4,741 16s. 0d., but this sum includes £30 412s. 6d. (part of the Royal Society's grant), expended on the extra number of the Quarterly Journal. The year opened with a balance in hand of £447 10s. 10d., and closed with a balance in hand of £419 15s. 7d.

The completion of Vol. LXXXIII of the Quarterly Journal was announced.

WOLLASTON MEDAL.

The Reports having been received, the President presented the Wollaston Medal to Dr. Dukinfield Henry Scott, addressing him as follows :—

Dr. Scott,— The lamp lit by the sparkling enthusiasm of Williamson amid the dark forests of the Coal Measures was first made clearer by your aid, and then borne forward by you to lighten the path for a host of younger followers who have since gained distinction for themselves. In a word, we honour in you to-day the founder and still the leader of the British School of Palæobotany. Botanists took but scant interest in Palæozoic plants before you, with Williamson, from 1894 onwards showed the importance of *Calamites*, *Sphenophyllum*, *Lyginodendron*, and others. Ten years later you were associated with Oliver in demonstrating the existence among the fern-like fronds of the Coal Measures of actual seeds instead of sporangia. From your independent researches I would select for mention that on *Lepilocarpon* : the lycopod cone which likewise produced seeds in place of naked sporangia, and that other complex cone, *Cheirostrobus*, from the Lower Carboniferous, with its curious combination of characters.

Your many more general writings, all marked by lucidity and scientific caution, have spread the gospel of Palæobotany, not only among geologists and botanists, but through a widening circle of the public. Of the many editions of your ' Studies in Fossil Botany ' the first was published in 1900, and quite recently we have had from you the deeply interesting volume ' Extinct Plants and Problems of Evolution.'

More need not be said, but I cannot close without alluding to the great collection of thin sections of Palæozoic plants which you have placed in the Geological Department of the British Museum, for I know how valuable an aid that has been and will be to all who study this ancient flora. My personal connection with you in this matter adds to the pleasure with which I place in your hands the highest honour that it is in our power to bestow.

Dr. Scott replied in the following words :

Mr. President,—This honour has come as a complete surprise, for I could not venture to call myself a geologist. The Society, however, has several times recognised Palæobotany in awarding the Wollaston Medal, notably in the cases of Brongniart (1841) the founder of modern Palæobotany, Dean Buckland (1848) famous in that subject as in geology generally, Oswald Heer (1874) the investigator of Tertiary Floras, and Williamson (1890) to whom the present recipient owes any success that he has met with. It was only a few days after that meeting that I first saw the treasures of the verted on the spot to Palæobotany.

Williamson was too busy at the time to attend in person, and Prof. Judd received the Medal on his behalf. Williamson's remarks, then read, related chiefly to the question of secondary or exogeneous growth in Cryptogams, which had been a subject of keen controversy. Williamson's conclusions were attacked from two sides, by certain English botanists who maintained that the growth in Carboniferous Cryptogams was not truly secondary, and (more formidably) by the French School under Brongniart, who recognised the secondary growth, but denied that the plants were Cryptogams.

Williamson was victorious on both fronts, and nobody now doubts that the giant Club Mosses and Horsetails of the Palæozoic Era adapted themselpes to arborescent habit by the same methods as our living tree. Then too, as now, secondary growth extended to small plants which were by no means of tree-like nature.

Since Williamson's time our knowledge of Palæozoic plants has greatly increased, bnt the difficulties have not proportionately diminished. The recent important discoveries in the Devonian floras by Kidson and Lang in our own country, Kraüsel and Weyland in Germany, and Halle in Sweden have opened up many new questions. With regard to the Carboniferous plants, you, Sir, have referred to the discovery of the Pteridosperms. But where are we to stop in transferring the old Ferns to the ranks of the Seed-plants? Dr. Kidston, the highest authority at the time, in his latest memoirs expressed grave doubts as to whether the typical " Ferns " of the Carboniferous, the so-called Marattiaceæ, were Ferns at all, and not themselves Pteridosperms. This example shows how the most fundamental questions in Palæozoic Botany are still open.

In conclusion, I would again express my warm thanks to you, Sir, for your kind words, and to both yourself and the Council for the great and wholly unlooked-for honour conferred on me this afternoon.

(To be concluded.)

SIR OLIVER LODGE, F.R.S.

An interesting ceremony occurred at Stoke-on-Trent on Wednesday, March 14, when Sir Oliver Lodge received the Freedom of the City. His father, Mr. O. Lodge was a merchant in the Potteries and Sir Oliver was born within the city's boundaries. He has since maintained his connections with the educational and other institutions in

FORTHCOMING EVENTS.

INSTITUTE OF METALS.

AUTUMN MEETING.

Members are reminded that the Annual Autumn Meeting will be held in Liverpool from September 4-7, 1928. It is hoped that the early notification will enable many Members to arrange to attend the Liverpool Meeting. The Local Reception Committee, under the Chairmanship of Professor C. O. Bannister, M.Eng., A.R.S.M., F.I.C., has already drafted a very attractive programme, details of which will be announced later.

Papers for the Liverpool Meeting should be received by the Secretary not later than April 30, 1928.

MANCHESTER LITERARY SOCIETY.

36, George Street, Manchester.

Chemical Section.—Tuesday, March 20, at 5.30 p.m.

MINERALOGICAL SOCIETY.

Tuesday, March 20, at 5.30 p.m.—" On the Atomic Volume Relations in Certain Isomorphous Series II." By A. F. Hallimond. " The Age and Composition of the Whin Sill and the Related Dikes of the North of England." By Prof. A. Holmes and Dr. H. F. Harwood. " The Identification of Dumortierite in Grains; Dumortierite in Cornish Granite." By A. W. Groves. " On Bauxite from Kashmir, India." By Dr. T. V. H. Rao.

THE PEOPLE'S LEAGUE OF HEALTH.

11, Chandos Street, Cavendish Square, London, W.

Friday, March 23, at 6 p.m.—" Diet in Rheumatic Diseases." By Dr. Bassett Jones, M.B.(Lond.).

THE PHYSICAL SOCIETY.

At the Imperial College of Science, South Kensington, on Friday, March 23 at 5 p.m.

Birmingham Section, at the Engineers' Club, Waterloo Street.—Tuesday, March 20, at 7 p.m.—W. E. Ballard : " Non-Ferrous Tubes."

ROYAL INSTITUTION.

21, Albemarle Street, W.1.

Tuesday, March 20, at 5.15 p.m.—" The Behaviour of Animals." By Prof. J. S. Huxley.

Thursday, March 22, at 5.15 p.m.—" Physiological Aspects of Flying." By Captain Martin Flack.

Friday, March 23, at 9 p.m.—" The Physical Chemist in Search of Purity." By Ernst Cohen.

Saturday, March 24, at 3 p.m.—" The Transformation of Matter." By Sir Ernest Rutherford.

ROYAL SOCIETY.

Burlington House, London, W.1.

Thursday, March 22, at 4.30 p.m.

SOCIETY OF GLASS TECHNOLOGY.

Wednesday, March 21, in The University, Leeds, at 2.30 p.m.—" The Study of a Fundamental Reaction in Glass Making." By J. T. Howarth, M.Sc., and Prof. W. E. S. Turner. " A Method of Testing the Probable Durability of Tank Blocks." By E. J. C. Bowmake, B.Sc.

ROYAL MICROSCOPICAL SOCIETY.

20, Hanover Square, London, W.1.

Wednesday, March 21, at 7.30 p.m.—Professor D. C. Blair, M.B., Ch.B. : " A Nerve Mechanism in the Capillaries of Muscle." Dr. J. A. Murray, F.R.S., F.R.M.S. : " Contribution to the Study of Diatom Markings." Dr. G. S. Sansom, D.Sc., F.R.M.S. : " A Portable Microscope Table."

ROYAL SOCIETY OF ARTS.

Wednesday, March 21, at 8 p.m.—(Ordinary Meeting). Captain Sir Arthur Clarke, K.B.E., Elder Brother of Trinity House, and Member of the Council of the Society : " Trinity House : Its History and its Work."

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

5,584.—British Celanese, Ltd.,—Production of oxygenated organic compounds. February 22nd.

5,500.—I. G. Farbenindustrie Akt.-Ges.-Bad Homburg.—Production of solutions of basic quinine. February 21st.

5,746.—I. G. Farbenindustrie Akt.-Ges.-Manufacture of 4-nitro-2-amino-1-benzoic acids, etc. February 23rd.

5,494.—Ormandy, W. R.—Manufacture of nitric acid. February 21st.

5,482.—Thorssell, T.—Production of potassium nitrate. February 21st.

Specifications Published.

257,270.—I. G. Farbenindustric Akt.-Ges.- Purification of the liquid complex hydrocarbon products of the destructive hydrogenation of carbonaceous materials.

285,551.—Boedecker, F.—Process for the preparation of vanillin and i-vanillin.

Abstract Published.

283,002.—Synthetic resins.—Petroff, G., 5, Tichwinskaja, Moscow.

Phenol-aldehyde condensation products. —The formation of the initial condensation products of phenols and aldehydes is effected in the presence of the sodium salt of toluene *p*-sulphonchloramide. The products may be hardened by heating, with or without the addition of acid or basic catalysts. Suitable acid catalysts are solutions of an acid in an alcohol, such as amyl or propyl alcohol, glycerol, or glycol, in a chlor-substituted hydrocarbon, such as tetrachlorethane, or in a fatty acid, and suitable basic catalysts are alcoholic solutions of glycerates and phenolates. In an example, commercial carbolic acid, formaldehyde, and the sodium salt of tlouene *p*-sulphonchloramide are heated under reflux, whereafter water is evaporated from the product. A solution of octa-hydroanthracene sulphonic acid in a mixture of ethyl alcohol and glycerine is then added, and the mass is allowed to stand and finally heated. Alternatively, there may be added to the initial product a basic catalyst prepared by adding glycerol to a saturated solution of caustic soda in ethyl alcohol and distilling off part of the alcohol. The sodium salt of toluene *p*-sulphonchloramide also may be used as a basic catalyst.

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CONTENTS. PAGE.

Scientific Methods in Metallurgy 177
By a Well-Known Engineer.
The Structure of an Atom of Nitrogen, VII. 178
By Hawksworth Collins, B.A. (Camb.).
Development of Standardisation and Simplification 180
General Notes 181
New Abstract Service 182
Wonderful Scope for the Research Chemist 183
Proceedings & Notices of Societies :—
The Royal Society 183
Institute of Metals 185
The Chemical Society 186
Geological Society 187
Forthcoming Events 191
New Patents 191

CANADA TO CONTROL ZINC MARKET.

The *Northern Miner* (Cobalt, Ont.), suggests that zinc production in Canada is likely to increase so rapidly during the next four years that the Dominion will dominate the world market for that metal, and that Canadian high-grade ore will be the ruling factor in controlling prices.

At present standing sixth among the countries of the world in zinc production, Canada is moving towards second place, and may shortly secure an output of zinc equal to one-half the production of the United States. Last year's world output was 1,450,000 tons, of which 612,000 tons originated in the United States, and 78,000

SCIENTIFIC METHODS IN METALLURGY.

THE EXAMPLE OF BRONZE SPINDLES FOR VALVES.

By A WELL KNOWN ENGINEER.

In modern engineering the metallurgist, the technical chemist, the physicist, and the research man generally are now being employed in thoroughly scientific fashion, and a good example are the methods in connection with bronzes for water valve spindles used by Messrs. Glenfield and Kennedy, Ltd., of Kilmarnock, who have extensive laboratories and testing equipment.

In the first place there is used for this purpose only the highest grade bronze forged from the billet, and methods such as cast brass or an inner core of steel are never employed. With regard to the particular tests it has been proved by long experience, quite apart from theoretical considerations, that figures for maximum stress and percentage elongation on test by themselves are of little value in determining the best physical properties for value spindles, since this does not take into account the close grain crystalline structure necessary.

For this reason the firm adopt as part of their routine, in addition to chemical analysis, the regular daily microscopical examination of all manganese forged bronze spindles, so as to ensure that this small crystal structure is present. Also they always employ the impact test, which is of value as an index to the resistance against sudden shock stresses.

Generally speaking, for the highest efficiency with bronze spindles it is found to be necessary for the metal to have (1) a high rate of elasticity limit to maximum stress, (2) elongation of over 30 per cent. on 2″ material, (3) high impact value, and (4) fine grain structure. All the bronze used for "Glenfield" valves fulfil these conditions, the standard specification being, a tensile stress of 30 tons per square inch, an elastic limit of 14 tons per square inch, 35 per cent. elongation on 2″ material, and an "Izod" impact test of 30 lbs. per square inch, together with a grain size under the microscope of 6,000 per square centimetres, entirely different from the polygonal large

THE STRUCTURE OF AN ATOM OF NITROGEN. VII.

By Hawksworth Collins, B.A. (Camb.).

The following matter concerns the sixth form of an atom of nitrogen. Its relative volume is 9.5, its heat of combustion (gas) is 23630, heat of formation (gas) -23630, heat of formation (aq. and liq.) -87070, magnetic rotation 0.735, and optical refra c tivity 2.8.

Table XLII.

The Relative Volume of Nitrogen, 9.5.

		Theor. S.G. at 15° C.	Obs. S.G.		Corresponds with
(1)	NH_3 9.5 + 0.97 + 5.76 + 9.95	0.649	0.643	-5° D'Andréeff	40
(2)	NH_2OH 9.5 + 0.97 + 5.76 + 2.51 + 5.76	1.35	1.35	Chem. Kal.	
(3)	N_2H_4 3.8 + 2(5.76) + 9.5 + 0.97 + 5.76	1.01	1.01	18° Eykmann	
(4)	$C_2H_5CO.NH_2$ 12.22 + 2(16.42) + 8 + 2.51 + 9.5 + 0.97 + 5.76	1.02	1.033	4° Schroder i.e., 1.024 15°	44
(5)	$(CH_3)_3N$ 2(12.22) + 5.76 + 3(16.42) + 9.5	0.663	0.662	-5° Nostrand	19
			0.673	O° Blennard	22
(6)	$(C_2H_5)_2NH$ 12.22 + 5.76 + 4(16.42) + 9.5 + 9.95	0.708	0.7098	19° Gladstone	41
(7)	Isobutylamine 15.25 + 4(16.42) + 2.27 + 9.5 + 0.97 + 5.76	0.7342	0.7357	15° Linnemann	21, 24
(8)	Tributylamine 2(12.22) + 5.76 + 12(16.42) + 9.5	0.781	0.778	20° i.e., 0.781 15°	
(9)	Triisobutylamine same + 3(2.27)	0.76	0.766	25° Nostrand	
(10)	Triisoabylamine last + 3(16.42)	0.78	0.785	25° Nostrand	
(11)	Tert. butylamine 12.22 + 4(16.42) + 2.27 + 9.5 + 9.95 + 5.76	0.6[illegible]	0.693	15° Rudneff	43
(12)	KCNS 18.637 + 8 + 9.5 + 15.53	1.88	1.866	14° Bodeker	35
			1.891	Schroder	
(13)	AmCNS 23.87 + 8 + 9.5 + 15.53	1.33	1.316	18° Dudley	
(14)	$Ba(NO_2)_2.H_2O$ 23.98 + 2(9.5 + 2 × 4.45) + 18.02	3.12	3.17	29° Nostrand	
(15)	$Ca(NO_2)_2.H_2O$ 12.24 + 2(9.5 + 2 × 4.45) + 18.02	2.237	2.231	34° Nostrand	
(16)	$LiNO_2.H_2O$ 6.12 + 9.5 + 2(4.45) + 18.02	1.67	1.67	21° Nostrand	
(17)	$Sr(NO_2)_2.H'_2O$ 28.98 + 2(9.5 + 2 × 4.45) + 14.03	2.647	2.645	27° Nostrand	
(18)	$Br.C_6H_4.NO_2$ 27 + 6(0.71) + 2(15.25 + 12.22) + 9.5 + 2(4.45)	1.931	1.934	22°	

The NO_2 in Nos. 14-18 corresponds with that in Nos. 25—33.

Table XLIII.

Heat of Combustion of Nitrogen, 23630 (gas).

			Theor.	Obs.	Corresponds with
(19)	$(CH_3)_3N$ 2(27858) + 26875 + 8(157787) + 23680	=	579072	582630	5, 22
(20)	$(CH_3)_2NH$ 27100 + 27858 + 2(157787) + 23630 + 26375	=	420532	420460	23
(21)	Isobutylamine 27100 + 4(157787) + 659 + 23680 + 18285 + 26875	=	727197	725360	7, 24

Table XLIV.

Heat of Formation of Nitrogen (gas), − 23630.

			Calculated by Collins	Calculated by Thomsen	Corresponds with
(22)	$(CH_3)_3N$ 2(6527) + 8005 + 3(7391) − 23630	=	19602	15870	5, 19
	also 9(34380 + 3(96418) − 579072	=	19602		
(23)	$(CH_3)_2NH$ 7280 + 6527 + 2(7291) − 23630 + 8005	=	12964	12720	20
	also 2(96418) + 7(34380) − 420532	=	12964		
(24)	Isobutylamine 7280 + 4(7391) − 659 − 23630 + 16095 + 8005	=	36655	38460	
				35560	7, 21
	also 11(34380) + 4(96148) − 727197	=	36655		

Table XLV.

Heat of Formation of Nitrogen (not gaseous), − 87070.

			Calculated by Collins	Calculated by Thomsen
(25)	$N.H_4.N.O_2$ aq. − 23630 + 4(8005) + 55960	=	64350	64950
				64200
(26)	$N.H_4.N.O_2$ − 20500 + 4(8005) + 55960	=	67480	68950
				64950
(27)	$H.N.O_2$ − 24350 + 55960	=	31610	30770
(28)	$Ag.N.O_2$ − 45080 + 55960	=	10880	11300
(29)	$Ag_2.O$ − 2(45080) + 96155	=	5995	5900
				7000
(30)	*$Ag.N.O_3$ − 45080 − 23630* + 3(32341)	=	28313	28700
(31)	$Na.N.O_2$ 32747 + 55960	=	88707	88520
(32)	Na.F 32747 + 76820	=	109567	109300
				109720
(33)	$K.N.O_2$ 33228 + 55960	=	89188	88900
	where 55960 = − 87070 + 2(71515)			
(34)	K.F. 33228 + 76820	=	110048	110000

The NO_2 in Nos. 25, 26, 27, 28, 31 and 33 corresponds with that in Nos. 14—28.

Table XLVI.

Heat of Formation of Nitrogen (solid), 30390.

			Theor.	Obs.	Corresponds with
(35)	K.CN.S 50324 + 30390 + 6217	=	86931	86700	12
(36)	K.Br 50324 + 45244	=	95568	95310	
(37)	K.CN 37274 + 30390	=	67664	67100	
(38)	$aq.K_2.S.O_4$ 2(37274) + 6217 + 2(32341) + 2(96155)	=	337757	338000	
(39)	aq. K.CN 33228 + 30390	=	63618	64090	
				62340	

where 30390 = 117460 − 87070

TABLE XLVII.

Magnetic Rotation of Nitrogen, 0.735.

			Theor.	Obs.		Corresponds with
(40)	NH_3(liq.) 0.735 + 0.5175 + 0.399 + 0.165	=	1.8175	1.818	Perkin	1
(41)	$(C_2H_5)_2NH$ 0.265 + 0.399 + 4(1.023) + 0.735 + 0.165	=	5.656	5.647 5.682		6
(42)	Isobutylamine 0.235 + 4(1.023) + 0.1 + 0.735 + 0.165 + 0.399	=	5.726	5.711 5.661		

0.735 is obtained from the Law of Magnetic Rotation by dividing half the atomic weight by the volume 9.5.

TABLE XLVIII.

Optical Refractivity of Nitrogen, 2.8.

			Theor.	Obs.		Corresponds with
(43)	Tert. butylamine 1.125 + 4(4.6135) + 2.8 + 1.125 + 0.82	=	24.324	24.09		11
(44)	$C_2H_5CO.NH_2$ 1.125 + 2(4.6135) + 3.333 + 1.346 + 2.8 + 1.0 + 0.82	=	19.651	19.58	67°	4
(45)	$C_6H_{13}CO.NH_2$ 19.651 + 4(4.6135)	=	38.105	38.25	112°	

In Table XLVI 30390 is the heat of formation, not from the element in its original gaseous state, but from that in its state of combination with C as given in No. 23, *The Chemical News*, 1927, cxxxv, 154, where its volume is 21.72.

BOARD OF TRADE ANNOUNCEMENT.

DEVELOPMENT OF STANDARDISATION AND SIMPLIFICATION.

The President of the Board of Trade (Sir Philip Cunliffe-Lister) presided at a meeting held on Thursday, March 8, to consider means for the further development of standardisation and simplification. A large number of representative business men were present.

The President recalled the resolution passed at the Imperial Conference in 1926 in favour of the further development of standardisation in the widest sense of the term and of Imperial co-operation for that purpose. Enquiries had since been proceeding with a view to giving effect to the resolution in this country. The movement had received a further impetus from the visit of Mr. Julius, the Chairman of the Australian Council for Scientific and Industrial Research and of the Commonwealth Engineering Standards Association, who had explained the steps taken to establish an Australian Association of Simplified Practice and had urged the desirability of Inter-Imperial consultation. It was felt that before this country was in a position to participate effectively in an inter-Imperial movement, some further progress must be made here, and the President had called the present influential meeting in order to ascertain the views of some of the representative associations in British industry on the question of initiating a forward movement here.

With regard to standardisation proper it was, of course, most desirable that the valuable work conducted by the British Engineering Standards Association should be continued and developed by that body. Attention had, however, been drawn—largely by the work done in the United States of America and Germany—to the great economies which might be effected in many trades by what was known as simplification or the elimination of unnecessary types of articles, to the consequent advantage of producers, distributors and users. This was work which must in detail be performed by those actually concerned in the particular industry in question, whether as manufacturers, dealers or users. At the same time the experience of other countries

confirmed the view that some central organisation was necessary to bring before particular industries the advantages of simplification and to assist those concerned in coming together for practical discussions.

He wished therefore to suggest that the meeting should consider whether it would be desirable to establish a central committee which would undertake this work. He did not think it could be done effectively by a Governmental department; what was needed was a representative body in close touch with the various branches of industry.

The subsequent discussion showed a general agreement as to the importance of developing standardisation and simplification further than the movement had yet gone in this country, and as to the necessity of having some central organisation of the kind suggested. The meeting requested that a representative of the Board of Trade should act as Chairman of the proposed body. It was accordingly decided to set up a Committee under the chairmanship of Mr. Herbert Williams, M.P., consisting in the first instance of the representatives of the Associations represented at the meeting, together with representatives of Government departments concerned. The first meeting of the new body was fixed for March 27.

GENERAL NOTES.

BOARD OF TRADE ENGINEERS AND SHIP SURVEYORS.

A competitive examination for one or fore appointments as Engineer and Ship Surveyor under the Board of Trade will be held in London on 5 June. The limits of age are from 25 to 40 years; the salary is from £300 to £500, plus bonus, which is at present £123 on a salary of £300.

Every candidate must possess either an Extra First Class (Board of Trade) Certificate of Competency as Engineer, or a First Class (Board of Trade) Certificate of Competency as Engineer, together with a B.Sc. (Engineering) or other equivalent voucher of scholarship.

Applications are to be made, not later than 17 April, on special forms obtainable from the Establishment Department (Mercantile Marine Branch), 20, Great Smith Street, London, S.W.1.

CZECHOSLOVAKIA'S TRADE WITH ENGLAND.

Czechoslovakia's trade with England in 1927 showed a big increase in volume, compared with 1926. The figures are :—

	1927.	1926.
	(in million	crowns)
Exports	1.827	1.548
Imports	1.520	608
	307	881

The development, it will be seen, has been largely in favour of England, a circumstance that should satisfy trade circles in this country, which have long complained of the adverse balance of imports from Czechoslovakia over exports to the Republic. While Czechoslovakia's exports to England have increased by 279 millions, her imports from England have grown by no less than 917 millions.

The outstanding change from the previous year is the big drop in sugar exports, as a result of the development of England's own sugar industry. Some considerable increases on the other hand are to be noted in England's purchases of cotton goods, iron goods, woollen goods, ready-made wearing apparel, cereals, and silk goods.

Among the more prominent increases in imports from England are those of wool, cotton, iron and iron goods, rubber and rubber goods, silk goods, and electrical machines and apparatus.

PUBLISHER'S ANNOUNCEMENT.

On behalf of *The British Journal of Ophthalmology*, the Cambridge University Press will shortly publish a monograph on "The Development of the Human Eye," by Miss Ida C. Mann. The volume, which contains a foreword by Sir John Herbert Parsons, is illustrated by 250 original drawings by the author.

A volume on "Ciliary Movement," by Mr. James Gray, Fellow of King's College, Cambridge, is shortly to be added to the "Cambridge Comparative Physiology" series, which the Cambridge University Press publishes. It will be followed by a volume on "The Biological Chemistry and Physics of Sea Water," by Mr. H. W. Harvey, Hydrographer at the Laboratory of the Marine Biological Association, Plymouth.

BOARD OF TRADE RETURN OF COAL OUTPUT AND WAGE EARNERS.

Districts.	Week ended 18 February. Output. Tons.	Wage Earners.	Week ended 25 February. Output. Tons.	Wage Earners.
Northumberland	270,500	45,500	272,900	45,400
Durham	713,200	125,900	719,800	126,200
Yorkshire	990,900	183,700	954,400	182,700
Lancashire, Cheshire and North Wales	403,900	98,400	406,800	98,300
Derby, Nottingham and Leicester ...	604,900	123,200	592,400	122,900
Stafford, Worcester, Salop & Warwick	382,700	83,900	374,100	83,400
South Wales and Monmouthshire ...	875,300	171,300	888,100	169,600
Other English Districts	108,600	27,200	110,000	27,200
Scotland	685,300	102,400	699,700	102,100
Total	5,035,300	961,500	5,018,200	957,800

NEW ABSTRACT SERVICE.

A new bibliographic reference service is announced by Smith and Smith, (Julian F. and Irene F. Smith), 138, Batchel Ave., Akron, Ohio. The purpose is to give technical men knowledge of the progress of technology each month in one or more selected subjects. In order to do this, chemical technology is divided in 36 classes. A monthly *resume* of the literature will be issued in each class in 3 ceparate parts : (a) Articles from periodicals; (b) Patents; and (c) Books and pamphlets. Subscribers may take any one or two or all three parts in any one or more classes. For a small charge added to the subscription price, two or more copies may be received. Thus the subscriber can assemble at very small expense, a classified monthly information bulletin, giving each member of the technical staff a copy containing only the subjects in which he is interested. In addition to the monthly subscription service, copies of original items will be sold or loaned and translations, detailed abstracts or searches will be made to order. Regular subscribers will be allowed a discount of 5 per cent. from the list prices for these accessory services.

CHEMICAL MANUFACTURERS' DIRECTORY.

The sixtieth edition (for 1928) of this handy and useful work comes to hand. It is published by Newnham, Cowell and Gripper, Ltd., 75, Chiswell Street, London, E.C.1. Price 4s. 6d. net. The class of business done is given alphabetically, with the names of the different firms, while particulars and classes of business are given also in alphabetical order. The work is compact and not over-weighted with useless matter.

TRADE UNDER MODERN CONDITIONS.

In the past trade followed the flag. To-day it is generated by judicions and persistent publicity and as the result of the facilities afforded for getting into quick touch with manufacturers and traders in all parts of all countries. No business book of reference in this connection renders more yeoman service than Sell's Telegraphic Address Directory, and in the new form in which it is issued for 1928, it cannot fail to achieve a record.

The latest edition is characterised by two main features of importance. On the one hand it contains in addition to 100,000 telegraphic addresses, valuable information on a host of subjects of undoubted value to the business house; on the other, while giving a greater wealth of facts and figures, it is not so bulky or heavy as to be troublesome.

Sell's Telegraphic Address Directory is a monument of painstaking compilation neatly adjusted to every business requirement. It is published at 8 and 9, Johnson's Court, Fleet Street, London.

MINERS' WELFARE.

The Secretary for Mines announces that the Sixth Annual Report of the Miners' Welfare Committee has now been published.

The report deals with the administration of the Miners' Welfare Fund during the year 1927, and includes as a snpplement the First Report of the Selection Committee appointed to administer the Miners' Welfare National Scholarship Scheme.

During 1927 the Miners' Welfare Committee made 702 allocations from the Fund, to the total amount of £1,090,734. Of this total £938,673 was allocated for local schemes on the recommendations of the District Welfare Committees.

COLLIERY TECHNICAL INVESTIGATION.

The British Colliery Owners' Research Association have appointed Mr. James S. Carson, B.Sc., to the post of Technical Investigator. Mr. Carson, who holds the Diploma in Mining of the Heriot Watt College, Edinburgh, and the B.Sc. degree in Mining and Metallurgy of Edinburgh University, was formerly employed by the Lothians Coal Company and later, by the Cramlington Coal Company, and at present occupies the position of Under-Manager at one of the collieries of the Ashington Coal Company.

The Association have recently been giving attention to the possibility of the increased use of iron and steel supports in place of timber underground, and the first work which Mr. Carson will undertake will be in this connection.

Under suitable conditions the use of steel in place of timber may conduce to better results, and if the use of steel instead of timber can be adopted on a considerable scale, the use of British-produced iron and steel in place of imported timber will not only be of very material benefit to the iron and steel industry, but will help the coal industry also, by increasing the demand for coal for iron and steel production.

"WONDERFUL SCOPE FOR THE RESEARCH AND TECHNICAL CHEMIST."

"There is a wonderful scope for the research and technical chemist, and the result might conceivably lead to discoveries of the highest importance," states a technical correspondent of the *Manchester Guardian Commercial Supplement*, in reviewing the progress made recently by low temperature carbonisation of coal.

Advocates of this system of treating coal, he states, have received much encouragement during the past year from the rapid development of comparatively new means of handling solid fuel and from the results of some useful investigations. Until quite recently, the chief aim of most low temperature carbonisation processes was the mauufacture of a robust, easily ignitible, freeburning, smokeless fuel, which it was thought would prove to be a useful substitute for the faw coal extensively used for the raw coal extensively used for domestic processes.

With the increasing adoption of fuel in the pulverised form, however, the original object has been considerably widened, and the outlook for a new carbonisation industry greatly enhanced.

Discussing the potentialities of low temperature by-products, the writer points out that the most valuable constituent of primary tar is motor-spirit which will, of course, be extracted, refined and marketed. The residual tar can then be used directly as boiler fuel, or it can be worked up in a variety of ways to give, say, burning oil, pitch, and tar acids, according to market requirements. As investigation of the raw material progresses, other means of utilisation may be found. Thus, it may be possible to convert the tar acids into hydro-carbons from which they differ only in containing oxygen. Useful work can also be performed in researches bearing on the refining of the spirit and burning oil fractions to reduce losses in producing a pitch satisfactory for road-surfacing and briquetting purposes and in the extraction, if such are present, of lubricating oils.

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.

The following papers were read at the meeting held on February 23 :—

The Yearly Variations in Plague in India in Relation to Climate :— Forecasting Epidemics. By SIR LEONARD ROGERS, F.R.S.

The monthly plague mortality in the more severely affected parts of India for nearly thirty years has been studied in relation to climatic variations, on similar lines to those which enabled the author to indicate methods of forecasting small-pox and cholera epidemics in India. The following are conclusions :—

1. The seasonal incidence of plague in India depends on monthly variations in mean temperature and humidity, expressed

as saturation deficiency, as pointed out by St. John Brooks.

2. Mean monthly temperature variations in hot weather and monsoon periods influence subsequent plague, through high temperatures reducing, and low once favouring, its prevalence.

3. Saturation deficiency in cold weather as well as in hot season influences plague incidence, through high saturation deficiency, indicating low relative humidity, reducing prevalence of plague, and *vice versa*.

4. The great yearly variations in plague can nearly all be explained by the influence of these climatic factors.

5. In the three northern areas, Punjab, United Provinces, and Bihar, four of the six climatic factors become evident before the annual increase of plague from December onwards, and thus allow the more important yearly increases and decreases to be forecast, as a rule. This is also the case to a large extent in Central Provinces. In Deccan, with early increase of plague during monsoon months, forecasts are of less value.

The North Chinese Species of the Genus Phlebotomus. By W. S. PATON AND E. HINDLE. Communicated by Dr. H. H. Dale, Sec.R.S.

Three species of sandflies were found in North China, *viz.*: *P. major* var. *chinensis*, a variety of *P. sergenti*, and a third species now first described, *P. taianensis*. The first two, in nature, seem to feed only on human blood; the latter on reptiles and batrachians. The former are of particular interest in connection with transmissions of *Leishmania*, as in both species the parasite readily develops to the flagellate stage, but only in one of them, *P. major* var. *chinensis*, is there any invasion of the anterior part of the alimentary canal.

Illustrated details are given of the distinguishing characteristics of the egg, larva, pupa, and adult of all three species. The bionomics of the three species differ to some extent. *P. major* var. *chinensis* normally has only one brood each year. The eggs are usually laid in June, the four larval stages are passed through during summer, the fourth stage larva remains unchanged throughout winter. About mid-May the larva pupates, the adult insect emerging about ten days later. This species only occurs for about six weeks, disappearing in July.

P. sergenti has a similar life-cycle, but frequently the larvæ complete their development, pupate, and produce another generation in one season. Consequently this species persists much longer and specimens may be found up to end of September. *P. taianensis*, n. sp., resembles the latter in its seasonal incidence, but whereas the two other species are found mainly in houses, this sandfly is especially prevalent in temples and open buildings.

In nature the larvæ of all three species live in cracks in the ground, and, being able to withstand freezing for several days, pass the winter in this stage without difficulty. Pupal cases were found in loose soil attached to pieces of tiles at a depth of 6-8 inches.

The distribution of Chinese sandflies is peculiar. Hitherto they have been found only in regions north of the Yangtze Valley. Their distribution, so far as known, agrees with that of Chinese Kala Azar, and supports the view that sandflies are responsible for transmission of this disease.

On the Producton of Silk by Species of the Genus Hilara *Meig.* (Diptera). *With an Appendix on the Habits of the Species, by A. H. Hamm.* By H. ELTRIGGHAM. Communnicated by Prof. E. B. Poulton, F.R.S.

The males of certain flies of the genus *Hilara* (*Empidæ*) are known to carry silken structures which may or may not contain insect prey or fragments of plants These structures are transferred to the females just before or at the instant of coitus.

The secretion of silk by a mature insect has been hitherto unknown, save in the Embiidæ, Psocidæ, and Hydrophilinœ. Thus, in order to spin together the leaves forming their nest, the workers of the tree-ant *Œcophylla smaragdina*, Fabr., are well known to employ their own larvæ, carrying them in their mandibles and using them as sewing machines. Many attempts, hitherto fruitless, have been made to discover the male silk-glands in *Hilara*, and a distinguished Dipterist has even thought that the cocoon-like structures are of vegetable origin and gathered by the insects.

It is here shown that the silk of the male is secreted by numerous unicellular glands situated in the dilated basal tarsi of the anterior legs, and that the duct of each leads to the base of a short hollow spine, from the apex of which the secretion can be forced to flow, hardening instantaneously on exposure to the air.

The Appendix records observations and experiments on the habits of the male *Hilara*, and evidence that the cocoons are transferred to the females during flight.

INSTITUTE OF METALS.

PRESIDENTIAL ADDRESS.

Dr. Rosenhain presented his Presidential Address on Wednesday, March 7, 1928, of which the following is a summary :—

After suitably acknowledging the honour done to him by his election to the Presidency, and referring to the loss which the Institute had sustained by the death of Sir Gerard Muntz, Bart., Dr. Rosenhain referred to the relative number of scientific and practical papers published by the Institute. He pointed out that although he would be regarded as a Scientific President he attached the greatest importance to practical papers and to the interchange of ideas and knowledge between practical men and scientific workers engaged on similar subjects. He wished, in fact, that the mutual understanding developed between these two classes of men by the work of the Institute might be extended also to the business men who control the finance of the non-ferrous metals industries. The purely scientific papers, however, were very valuable and the high reputation of the Institute of Metals depended to a considerable extent upon the papers of this type which the Institute publish. There was, however, a wide field of common interest between scientific and practical men and he would devote his Address to an endeavour to widen this field a little further.

Much criticism has been heard from the members engaged in practical metallurgy on the number of equilibrium diagrams described and published in the Journal of the Institute. It was, therefore, worth while trying to show to the practical man the real value and importance of these diagrams. In studying alloy systems, it was possible to prepare first a series of tables of interesting properties for a number of alloys of varying composition. Later, graphs could be plotted representing the variation of properties such as strength, ductility, etc., with composition. These graphs were not regular; there were irregularities and anomalies which it was not easy to explain. It had been found by study of the microstructure of alloys that there was a close correlation between microstructure and all or most of the physical properties. So close was this connection that in many cases an exploration of a new alloy system could be confined in the first instance to a study of the microstructure, the physical properties being only tested in a few cases where the microstructure indicated that good results would be obtained. The microstructure, however, was the direct result of the mode of solidification of the alloy. Actually, the structure of an alloy was in many respects more important than its chemical composition and accordingly it became important for the metallurgist to know how the various structures were formed. The most valuable diagram or chart which could be prepared for a series of alloys, therefore, was a chart showing the way in which the alloys solidified and the changes which they underwent, in regard to structure, upon cooling after solidification. A diagram of this kind, if sufficiently complete, was generally known as an "Equilibrium Diagram." This somewhat formidable term, however, merely meant that the diagram represented those conditions which the alloys tended to assume if they were allowed to attain their final condition of balance. It was pointed out that the condition of an alloy at any moment is the result of the balance of various changes taking place in it simultaneously. If these changes are allowed to go to completion, then the balance becomes stable and the alloy is said to have attained equilibrium. These changes, however, were governed by well defined laws among which the well-known "Phase Rule" was perhaps the most important. Dr. Rosenhain then indicated the general ideas of the running down of energy or power and the equalisation of what is known as "potential" as forming the basis upon which the theory of the phase rule had been erected.

In describing the various lines of the equilibrium diagram Dr. Rosenhain pointed out the necessity for accurate determination and said that his criticism of some of the earlier diagrams, made in a paper published at the first meeting of the Institute of Metals in 1908, had since been very thoroughly verified. As an example of the need of great accuracy and completeness in the study of these diagrams an account was given of the method of determining the "solubility lines" of various alloy systems. These determinations, which at first sight appear to yield results of purely academic interest, have proved of the greatest practical importance. They have not only furnished the explanation of the age-hardening of duralumin and other aluminium alloys, but form the foundation for a series of new and important alloys of copper and other metals. In some of these, notably the alloys of copper and beryllium recently developed in Germany, the age-hardening effects were very large. An alloy containing only a small percentage of beryllium in copper could

have its Brinnel hardness raised from 80 to 410 by age-hardening, the tensile strength in the latter condition being of the order of 90 tons per square inch. A practical achievement of this kind was surely a vindication for the need of studying equilibrium diagrams very thoroughly. It was true that this study might not assist the manufacture of ordinary brass and bronze, but in the rivalry between such material as rust-resisting steel and non-ferrous alloys, the production of high-strength copper alloys might prove to be of vital importance to the future of the non-ferrous industries.

The following papers were then presented :—

The Deterioration of Lead Cable Sheathing by Cracking and its Prevention. By S. Beckinsale, B.Sc., A.I.C., and H. Waterhouse, M.Met.

The phenomenon of the cracking of lead cable sheathing had received little attention until recently, when the problem has been studied in America and Germany as well as in this country. The authors of the present paper have examined large numbers of cables with cracked sheaths, and have considered the positions in which they failed. The cracks were found to be intercrystalline, had commenced on the inside of the sheaths and were generally free from corrosion. The lead in the region of the cracks was not distorted.

Definite evidence was obtained that where lead sheathing failed by cracking, the cable was in a state of vibration. Alternating stress tests on lead and its alloys in the Haigh machine indicated that lead has a very low fatigue limit, and the fractures obtained in the pure lead test pieces were similar in all respects to those found in failed cable sheathing. The conclusion was, therefore, reached that the cracking is a fatigue type of failure.

The addition of other metals to lead greatly raised its fatigue limit, and amongst the most effective additions is cadmium. The properties of certain ternary lead alloys containing cadmium have been investigated, and their high fatigue limit (more than three times that of lead) and resistance to oxidation and corrosion, make them very suitable for cable sheathing which has to withstand vibration.

Explanations other than the above which have been advanced to account for the cracking have also been investigated. These included the presence of deleterious impurities in the lead, overheating during working, abnormal grain size, allotropic change, intercrystalline corrosion and prolonged tensile stress. Of these two, intercrystalline corrosion and prolonged stress might cause intercrystalline cracking in lead, but cracks produced by the former are associated with much corrosion product, and by the latter with much deformation of the lead.

THE CHEMICAL SOCIETY.

Papers read at the meeting held on March 15 :—

Mobile-Anion Tautomerism. A Preliminary Study of the Conditions of Activation of the Three-carbon System, and a Discussion of the Results in Relation to the Modes of Addition to Conjugated Systems. By H. Burton and C. K. Ingold.

An examination has been made of the relative mobility of X (= OH, OAc, Br) and its facilitation by R (= Me, Ph, *p*-Me.C_6H_4, *p*-Cl.C_6H_4.) in R.CHX.CH :CH_2.R' $\rightleftarrows$ R.CH :CH :CHX.R', and of the effect of R on equilibrium. The order of increasing mobility is as indicated in each series, and hence corresponds with the anionic stability of X and the power of R to take up the cationic charge.

The Absorption-Spectra of Prototropic Compounds. Physical Properties of the Enolic and Ketonic Forms of Benzoylcamphor. By T. M. Lowry, C. A. H. MacConkey and H. Burgess.

Measurements have been made of the m.p., optical rotation, rotatory dispersion, solubility and ultra-violet absorption of the enolic and ketonic forms of benzoylcamphor.

Contrary to an earlier statement "that the two isomeric forms of benzoylcamphor give bands at the same wave-length, but of unequal intensity," it has been found that the absorption bands of the enol and ketone are of nearly the same intensity, but differ widely in wave-length. The absorption of the equilibrium-mixture in very dilute alcoholic solutions corresponds closely with that of a mixture of two parts of enol and one of ketone.

Van't Hoff's relation between the solubilities of the two forms and their equilibrium-concentrations has been tested for solutions in alcohol, acetone and benzene and found to hold good within ± 80 per cent.

The ratio of the initial and final solubilities of the enolic form indicates that the equilibrium mixture in a saturated alcoholic solution contains about 58 per cent. of enol, in close agreement with the proportion, 59 per cent, deduced from the optical rotations of the solutions.

The Parachor and Chemical Constitution. Part IX. Boron Compounds. By J. J. ETRIDGE AND S. SUGDEN.

Pure specimens of methyl and ethyl borates have been prepared by the action of boron trioxide on the alcohol and fractionation of the crude product, the separation being followed by analysis. Methyl alcohol and methyl borate form a mixture of maximum vapour pressure boiling at 55° and containing 30 per cent. of the ester.

The surface tension and density of these esters have been determined; the parachors calculated from these data and from the observations of Mills and Robinson (J., 1927, 1823) on boron trichloride give a mean parachor for boron of 16.0. The atomic parachors of elements of the first period show, threfore, a marked minimum at carbon.

Li	Be	B	C	N	O	F
c.50	—	16.0	4.8	12.5	20.0	25.7

Observations on the Passivity of Metals. By E. S. HEDGES.

Reproducible values for the lowest concentration of nitric acid necessary to passivate electrolytic iron can be obtained if care is taken to ensure that the iron passes rapidly through the surface of the liqnid. The liquid surface has an activating influence. When passive iron was whirled at 3,000 r.p.m. in nitric acid of this concentration, it became active after a short induction period. This is shown to be in accordance with the oxide film theory, the induction period representing the time for removal of the film, but is at variance with the theory advanced by Smits. When passive iron in strong nitric acid is heated, dissolution of the metal begins at 74.5 to 75.5°, independent of the concentration of the acid. Freshly-ignited ferric oxide is not appreciably dissolved by strong nitric acid until this temperature is reached, and this temperature does not represent an allotropic change in the metal. Other metals can be passivated by nitric acid at lower temperatures: *e.g.*, at - 11°, copper becomes passive in concentrated nitric acid and is covered by a visible oxide film when in this state. Periodic phenomena were observed in the activation of passive iron, both by rise of temperature and by catholic polarisation. It is concluded that passivity produced by anodic polarisation and by purely chemical means is the same phenomenon, that it is the result of the formation of a film of oxidised material, and that the phenom enon is exhibited to different degrees depending on the protective properties of the film under the particular conditions prevailing. A theory of the mechanism of anodic polarisation is advanced.

GEOLOGICAL SOCIETY OF LONDON.

(*Continued from Page 174.*)

The Annual General Meeting was held on February 17, 1928, Dr. F. A. Bather, M.A., F.R.S, President, being in the chair.

MURCHISON MEDAL.

The president then handed the Murchison Medal (awarded to Dr. Jakob Johannes Sederholm) to His Excellency the Finnish Minister, Mr. A. H. Saastamoinen, for transmission to the recipient, addressing him as follows :—

Your Excellency, — The 'Land of a Thousand Lakes' is an ancient land, the foundations of which were fashioned in that 'dim backward and abysm of time' ere life as we know it was visible on this planet. Subjected to formidable pressure and a succession of might forces, those foundations and their superstructure have been so changed and twisted that Finland presents a greater problem to the geologist than does any country of Europe. He who would read its history has not the guidance of those time-daters we call fossils, but must unravel the tangle through minute examination of the rocks and study of the processes by which they have been altered from their primitive simplicity. If to-day some clarity has replaced obscurity, if a succession of ordered systems (Jotnian, Jatulian, Kalevian, Bottnian, and Ladogian) has replaced apparent chaos, thanks are due above all to Dr. Jakob Johannes Sederholm, to whom the Council of this Society has awarded the Medal instituted by the great geologist, who, in his day, accomplished the similar but easier task of founding the Silurian System.

The social structure of a country is the result of long historical changes and the reaction of living men to their surroundings. So, too, Dr. Sederholm sees in the very rocks 'things with a history, which may be read by the study of their present characters. Geology,' he adds, 'is a science of

time, studying the succession of events.' The laws of physics and chemistry act no doubt, but they act under conditions which constantly vary, and on material that reacts hardly less than that which we call living. To take but a few examples: Sederholm was the first to express the idea that the character of the metamorphic processes changes with varying depth; he has shown how igneous rocks, like a fiery dragon, eat the sedimentary rocks and produce a mixed group, which he names migmatites; these he has studied with a wealth of detail in a recently published memoir of the utmost importance; he has also described the life-like growth of certain minerals that are born in the rock where one mineral meets another; and he has drawn a useful distinction between those changes in an igneous rock which merely continue its solidification and those subsequently impressed on it by outer agencies.

I now ask Your Excellency to receive this medal and to transmit it to our distinguished Foreign Member with our assurance that the work that he has accomplished will increasingly prove its value as the years pass, and with our hope that he may long continue to add to its volume.

The Finnish Minister replied in the following words:—

Mr. President,—It is a very great honour for me to receive on behalf of my celebrated countryman and great personal friend, Prof. Sederholm, the Murchison Medal.

You know, Mr. President, in what high regard we in Finland hold your country and, therefore, we are doubly proud that a countryman of ours has merited this great honour and distinction. We feel that—while it is a personal award to Prof. Sederholm—it is at the same time a recognition of scientific research in Finland.

With your permission, Mr. President, I will read a letter by Prof. Sederholm, addressed to your Society.

'I feel particularly happy because this high distinction has been awarded to me by a Society which is the guardian of the great traditions of British geology, to which I am myself so much indebted. When writing my first detailed description of an Archæan sedimentary series, I quoted, as an introduction, some words of Charles Lapworth, who said that many British geologists, followers of Hutton, Lyell, and Darwin, expected that future research would demonstrate the existence of many Archæan systems, but of the same characters as those of the post-Archæan rocks.

'The words expressed, in the main, the programme of my life's work, in which petrological research has been the means, the attainment of geological knowledge the aim. My work has often been hampered by many adverse circumstances, sometimes keeping me for years away from scientific activity, but, if a few additional years are granted to me, I hope to be able to bring it to a preliminary conclusion, and thus in the future better than now merit an honour of this exceptional character.'

Our common friend, Prof. Sederholm, asks me to convey his cordial personal greetings to his many friends in this Society.

Again, in the name of Prof. Sederholm, I wish to thank you, Mr. President, and the Council of the Geological Society for the award of the Murchison Medal.

LYELL MEDALS.

In presenting a Lyell Medal to Prof. Sidney Hugh Reynolds, the President addressed him as follows:—

Professor Reynolds,—Sir Charles Lyell directed that the Medal which bears his name should be given to one who 'has deserved well of the Science.' There are several ways in which a man may fulfil this conditin, but few men fulfil it in so many as you have done. During the twenty-four years that have elapsed since you received a moiety of the Lyell Geological Fund, while actively continuing your duties as Professor of Geology at Bristol University, you have lost no opportunity of escaping from the lecture-room into the greater school of Nature and acquiring fresh knowledge for transmission to your colleagues. Not only have you continued with C. I. Gardiner your important work on the Lower Palæozoic rocks of Ireland, but the obscure Silurian inlier of the Mendips, the stratigraphy, composition, fossil content, and structure of the Lower Carboniferous Series in Somerset, and the igneous rocks of Tortworth, all are subjects on which we have received from you valuable communications. No less valuable are those thorough and lucid summaries intended for a yet wider circle; your Handbook to the Bristol District, your account of the Palæozoic rocks of that region in the Jubilee volume of the Geologists' Association, and above all your exhaustive Presidential Address to the Geological Section of the British Association on the Lower Carboniferous rocks of England and Wales.

For recreation you have proceeded with your Monographs of the Pleistocene Mammalia, dealing successively with Bears,

Canidæ, *Hippopotamus*, and now the Cervidæ—a work that should be most useful to the active cave-hunters of Bristol.

Finally, for many years you have found time to serve as secretary to the British Association Committee of Photographs of Geological Interest, and when I observe that the number of subjects now reaches 7,623, and that no fewer than 443 prints were received in the last year, I feel that almost for this alone you deserve the Medal which it is my privilege to hand to you.

Prof. Reynolds replied in the following words :—

Mr. President,—I value very highly the honour which the Council of the Geological Society has done me in awarding to me a Lyell Medal, and am happy to think that one of the earlier recipients was Prof. T. McKenny Hughes, to whose stimulating personality I owe the fact of having taken up the study of Geology at Cambridge.

I have worked much in collaboration, and for anything that I may have accomplished I owe much to association with others. You, Sir, have alluded to work on the Bristol Silurian rocks, to which I was first introduced by my former chief, Prof. C. Lloyd Morgan, and to study of the Irish Lower Palæozoic rocks with Mr. C. I. Gardiner. Like dozens of other young Cambridge geologists, Gardiner and I owed our first start in field geology to Prof. Marr, and at his sugestion began work in Ireland in 1893. Except during the War and during certain years when I was abroad, we have been in the field together in every subsequent year, and I cannot say how much I owe to his cheery companionship and collaboration. You allude to progress in the study of the Carboniferous Limestone. It is scarcely necessary to say that the inspiration for all such investigation in the Bristol district is due to the late Arthur Vaughan, whose work is being carried on by what may perhaps be termed a small school of Bristol geologists. Finally, Sir, you refer to the Palæontographical Society's Memoirs on Pleistocene mammals. I feel in this connection that, as a geologist, I have no right to stray into a field which is in reality pure Zoology. But for many years at Bristol I was engaged in teaching Zoology as well as Geology, and I am glad to keep up some small connection with Zoology. I thank you, Sir, for the all too kindly way in which you have alluded to what I have been able to accomplish.

The President then presented a second Lyell Medal to Dr. William Dickson Lang, addressing him as follows :—

Dr. Lang,— Twice before in the history of the Lyell Medal the Council, unable to distinguish between the claims of two workers, has awarded two Medals. The Will permits of this when the ' two persons have been jointly engaged in the same exploration.' In seeking how to reconcile this with the Council's present action, I find that, at any rate, you, like your fellow-recipient, have, in addition to your official duties, done work in Palæontology, in Stratigraphy, and in the presentation of results to a larger audience. On these paths you have reached a very high level. I need but mention your excellent exhibits in the geological galleries of the British Museum, your remarkable volumes in the Catalogue of Cretaceous Polyzoa, the papers on Palæozoic Corals to which we have had the pleasure of listening here, your patient and exhaustive study of the Charmouth Lias, and the suggestive treatment of evolutionary problems with which you have so often entertained the Geologists' Association. All your work pays the closest attention to detail, and follows with precision the technical rules; but its many minute statements of dry fact are underlaid by a background of deeply-reasoned philosophy, which not only binds them into solid science, but ever and anon radiates through the close-knit fabric sparks of illuminating thought. It is a peculiar pleasure to me to hand to my colleague of many years, the new Keeper of Geology in the British Museum, this well-earned ' mark of honary distinction.'

Dr. Lang replied in the following words :

Mr. President,—Naturally, I am grateful to a Society numbering many personal friends for conferring upon me this honour, and I heartily thank the Fellows for it; but I am particularly pleased at receiving it at your hands.

When, more than twenty-five years ago, I joined the staff of the Geological Department of the Natural History Museum, I was placed under your charge by your illustrious predecessor in the Keepership. I had been first taught biology at Harrow by one who, I believe, was an Oxford contemporary of yours, one who, even then, pointed to you as the authority on fossil echinoderms, I mean Mr. Archer Vassall, who was trained and who trained me, in the severely morphological school of Haeckel and Ray Lancaster. At Cambridge, the biological atmosphere was freer, one might almost say that there were as many schools as teachers, and it is not surprising that I hould have come to you from there, that I have remained ever since, biologically a free-lance. It devolved

upon you (though perhaps you did not know it) to keep to the rigid orbit of observed fact a mind naturally prone to speculation, when it would unduly sway, now towards the allurements of, shall I say?, the school of Hyatt, now to the attractions of an Eimer.

(*To be concluded.*)

NOTICES OF BOOKS.

Chemical Encyclopædia. An Epitomised Digest of Chemistry and its Industrial Application. By C. T. KINGZETT, F.I.C., F.C.S. Pp. VII + 808 roy. 8vo. Price, 35s. net. London: Baillière, Tindall and Cox, 7 & 8, Henrietta Street, Covent Garden.

The present is the fourth edition of this well-known and most useful book of references. Mr. Kingzett is a veteran chemist of the practical kind, and the author of several important works. While the Encyclopædia is indispensable for most persons connected with chemistry, it will also prove a most welcome addition to any scientific or even general library and is certainly good value for money, being comprehensive, compact, and well arranged. The following extract will give some idea of the style of the work:

CHROMOGENS.—The parent group of dyestuffs formed by substitution of chromophores in hydrocarbons, and when, in addition, a strong basic or acid group (such as NH_2 or $.SO_2.OH$) is also present, dyes are obtained. (See Azo-dyes.)

CHROMOPHORES.—The particular atomic groupings characteristic of coloured organic compounds, such as .N : N and NO_2—for example, azobenzene ($C_6H_5 : N : N.C_6H_5$), which is a chromogen containing the chromophore —N : N—. (See Azo-dyes and Chromogens.)

CHROMOPLASTS. — The chromo-coloured matters in plant cells. (See Plant Colouring Matters.)

CHRYSAMINE.—A substantive yellow coal-tar dye of the Congo class used in the leather and textile trades, prepared from salicylic acid and benzidine.

CHRYSAROBIN.—See Chrysophanic Acid.

CHRYSAZIN (*Dihydroxy-anthraquinone*, 1 : 8) ($C_{14}H_6O_2OH)_2$).—A reddish-brown, crystalline body, m.p. 191° C., soluble in alcohol, used in dye-stuffs.

CHRYSENE ($C_{18}H_{12}$).—A white, crystalline hydrocarbon contained in the coal-tar distillate which comes over above 360° C. It melts at 250° C., boils at 448° C., and resembles anthracene in properties.

CHRYSOBERYL.—A mineral of crystal system, No. 4, and sp. gr. 3.5 to 3.8, consisting of the oxides of aluminium and beryllium (Al_2O_3BeO).

CHRYSOIDINE.—An orange-red colour which dyes silk and wool directly. It is a hydrochloride of diamido-azobenzene ($C_5H_5N_2,C_6H_3(NH_2)_2HCl)$), and is slightly soluble n water.

CHRYSOLITE ($2(MgFe)O.SiO_2$).—A mineral double silicate of magnesium and iron; cystal system, No. 4, and sp. gr. 3.3 to 3.5.

CHRYSOPHANIC ACID (*Chyrsarobin*) ($C_{30}H_{26}O_7$). — Prepared from Araroba (Goa powder), which is deposited in the wood of *Vouacapoua araroba*, by extraction with hot chloroform, and is also a constituent of senna. It is soluble n water, alcohol, and ether, melts at 157° C., and is used in unction form in cases of *alopecia*, ringworm, and other skin affections. For abstract of a paper on the composition of chrysarobin, by R. Eder and F. Hausen, see *J.C.S.*, 1925, p. 1160T.

The Structure of an Organic Crystal. Fison Memorial Lecture, 1928. By SIR WILLIAM BRAGG, K.B.E., F.R.S., M.A., D.Sc. Price 1s. 6d. net. London: Longman's, Green and Co., Ltd., 39, Paternoster Row.

Sir William Bragg is such an eminent scientist that he can invest any scientific subject has a special interest. He has the peculiar faculty of making his subject —abstruse though it may be—appear simple even to the non-scientific reader. In the present, the third Fison Memorial Lecture, he stresses the importance of carbon in the world, pointing out that while oxygen constitutes about 50 per cent. of the known world, silicon a fourth, and aluminium a large part of the balance, yet carbon, which forms only a fraction of one per cent. of the world, is the most important of all the elements. The lecture is handsomely printed and contains a mass of useful information to either the scientific or an intelligent non-scientific reader.

Volumetric Analysis for Students of Pharmaceutical and General Chemistry. By CHARLES H. HAMPSHIRE, B.Sc. (Lond.), F.I.C. Fourth Edition. Price 7s. 6d. London: J. & A. Churchill, 40, Gloucester Place, Portman Square, London, W.1.

The present is the fourth edition of this very handy and useful volume, which, while

subject naturally to revision, has followed the general make-up of previous editions. The Book is all the more valuable because of its conciseness, containing nothing of a redundant nature. Certain sections of the work are printed in large type, containing a broad general knowledge of volumetric methods, while other sections, printed in smaller type, deal in much greater detail with the subject, and appeal more particularly to advanced students.

FORTHCOMING EVENTS.

THE ILLUMINATING ENGINEERING SOCIETY.

32, Victoria Street, London.

Tuesday, March 27.—A discussion on various aspects of street lighting.

INSTITUTE OF METALS.

Sheffield Local Section.—Friday, March 30, at 7.30 p.m., at the Applied Science and Art Department, The University, St. George's Square.

PEOPLE'S LEAGUE OF HEALTH.

11, Chandos Place, Cavendish Square, London.

Friday, March 30, at 6 p.m.—" Common Errors in Daily Life." By Mr. Eric Holmes, M.B.

ROYAL INSTITUTION.

21, Albemarle Street, W.1.

Tuesday, March 27, at 5.15 p.m.—" The Behaviour of Animals." By Prof. J. S. Huxley.

Thursday, March 29, at 5.15 p.m.—" Physiological Aspects of Flying." By Capt. Martin Flack.

Friday, March 30, at 9 p.m.—" Radio-active Atoms and their Structure." By Sir Ernest Rutherford.

ROYAL SOCIETY OF ARTS.

Tuesday, March 27, at 4.3 p.m.—Dominians and Colonies Meeting.

Wednesday, March 28, at 8 p.m.—Ordinary Meeting. Lt.-Commander R. T. Gould, R.N.: " The Mechanism of the Modern Typewriter."

SOCIETY OF PETROLEUM TECHNOLOGISTS.

At the House of the Royal Society of Arts.

Tuesday, March 27, at 5.30 p.m.—Annual General Meeting.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

6,495.—Bensa, F. — Manufacture of highly-chlorinated perylenes. March 1st.

6,509.—Erzröstung, Ges. — Calcining zinchlende, &c. March 1st.

6,462.—I. G. Farbenindustrie Akt.-Ges. —Production of azo-dyestuffs. March 1st.

6,522.—Metallbank und Metallurgische Ges. Akt.-Ges.—Production of anhydrous zinc chloride. March 1st.

6,746. Stocks, H. H. — Process for manufacture of xanthen dyes. March 3rd.

Specifications Published.

286,005.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of new indophenols leuco-indophenols and new dyestuffs therefrom.

281,650.—Deutscbe Gold- und Silber-Scheifeanstalt Vorm. Roessler.—Prepar-2-chloropyridine.

286,196.—Chemische Fabrik auf Actien (vorm. E. Schering).—Manufacture of guanidine derivatives.

285,932.—Chemische Fabrik auf Actien (vorm. E. Schering).—Manufacture of substituted guanidines.

286,087.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of new poly-amino compounds.

Abstract Published.

283,482.—Dyes.—Durand and Huguenin Akt.-Ges., Basle, Switzerland.

Azo dyes.—Brown mordant dyestuffs are obtained by diazotizing an aminoazo compound of the type $R^1 - N = N - R^2.NH_2$ in which R^1 is an aromatic residue containing a hydroxyl group in *o*-position to a carboxyl group, and R^2 is an aromatic residue containing a sulphonic or carboxyl group, and treating the resulting diazo compound in an alkaline or acid medium at ordinary or a raised temperature until its coupling power has disappeared. The following examples are specified. (1) The dyestuff obtained by reduction of the nitro group of

the dyestuff *p*-nitraniline-*o*-sulphonic acid → salicylic acid is diazotised, the diazo compound is stirred with dilute ammonia at ordinary temperature until the blue colour disappears, and the solution is acidified to precipitate the final dyestuff. The product yields a fast reddish brown tint when chrome printed on cotton. (2) The diazo compound in (1) is boiled with dilute hydrochloric acid until a sample no longer yields a blue colour with ammonia. The product yields a yellower tint in chrome printing than that according to (1). (3) The acetyl group of the dyestuff 4-acetylaminoaniline-2-sulphonic acid → *m*-cresotinic acid is saponified and the product is diazotized. The diazo compound is stirred with dilute ammonia at ordinary temperature until the blue colour disappears, and the final dyestuff is precipitated by acid. The product yields a redder tint in chrome printing than that according to (1). (4) The dyestuff obtained by nitration of the dyestuff anthranilic acid → salicylic acid and reduction of the nitro group is diazotized, and the diazo compound is stirred with dilute ammonia at ordinary temperature. The final dyestuff is isolated as an alkali salt and yields a yellower tint in chrome printing than that according to (1).

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CONTENTS. PAGE.

Atomic Electricity Explained and Explained Away ... 193
By Dr. W. Tombrock.
An Atomic Model for the Chemist ... 194
By Florence Langworthy.
Action of Thionyl Chloride on Organic Acids ... 196
By L. McMasters and F. F. Ahman.
General Notes :—
Goodwill in Industry ... 198
The Electro Reduction of Organic Substances ... 199
Wholesale Prices in February ... 199
Transformation of Matter ... 200
Proceedings & Notices of Societies :—
The Royal Society ... 201
The Society of Public Analysts ... 202
Royal Agricultural Society ... 203
Geological Society ... 203
Notices of Books ... 205
New Patents and Trade Marks ... 207

ATOMIC ELECTRICITY EXPLAINED AND EXPLAINED AWAY.

A Plain Hypothesis about the Structure of Ether, Protons and Electrons.

By DR. W. TOMBROCK.

When van't Hoff laid the foundation of stereo-chemistry with a simple, clear, in every respect understandable and acceptable supposition, he gave a confirmation of Boerhaave's motto—*simplicitas veri sigillum* —simplicity the characteristic of truth. What amazing and rare consequences did we not see of his conception, as simple as it was ingenious, of the constitution of matter in its microcosmical dimensions?

Van't Hoff here gave a fundamental principle in the construction of the molecule from atoms: the present time busies itself with the constitution of the atom itself.

Rutherford conceives the atom as a planetary system. Electrons circulate round protons—as many electrons as the nucleus of the atom has positive charges.

Bohr imagines the electrons in orbits and as jumping from one orbit to another. When the electron jumps from a greater to a smaller orbit, the atom gives up energy, when the opposite takes place it takes up energy.

These two atom models are certainly clear. But do they bring satisfaction to anyone who amuses himself with considering these suppositions in greater detail?

First of all why or rather by what means do the electrons remain circulating round the nucleus What causes the circular closed orbit? Centripetal force, one says. What is that? The attraction of the positive on the negative electrical charges. The considerable continuous motion (translation) of the electron hinders the approach to the nucleus. What is this attraction, what is positively, what is negatively electrically charged?

It is certain that putting a + or a - sign or a dotted line which is drawn round or inside a given vicinity, gives us no satisfactory answer to our questions.

Indeed if this question " What is electricity? " must receive an answer, then it is here and now......do we not here in thought stand at the ultimate division of matter?

My answer now is this.

Atoms are constituted of protons, the number of which is related to the atomic weight.

Protons are larger material particles with strongly rotary motions.

Round the protons and between them the electrons circulate in the atom, the electrons being smaller material particles with strongly rotary motion.

The difference between protons and electrons exists only in their size and type of motion......both have this fundamental materal property in common, that they cannot occupy the same place at the same time.

Matter is the substrate of all physics, matter is all that which moves. Ether is thus also matter and because of the above mentioned *fundamental hypothesis, that two material particles cannot occupy the* same place at the same time, the ether must be divided into small particles......otherwise no motion would be possible in the ether.

The motion of the ether particles, in analogy between light and sound, I imagine

as that of gas molecules; the velocity is naturally much greater in this case.

If an ether particle collides with the proton mill of the atom, then a probability exists of it being compelled to follow an electron orbit, and thus indeed function as an electron and also that it is presently shot out as a more or less active electron. The velocity will in general be smaller as regards the translation—greater as regards the rotary motion.

Whoever wishes further to embroider this theme will see that light is primarily emission, secondarily undulation......photogenic electrons move through the ether like projectiles rotating round their axes, causing disturbances in the ether which recall the idea of a screw.

In the difference of the motion of the ether particles towards and away from the atom (out of the proton mill) may be hidden an origin of force—gravitation!

SUMMARY.

Atoms are constituted of protons, the number of which is related to the atomic weight.

Protons are larger material particles with stronger rotary motion.

Electrons are smaller material particles with considerable translatory, less rotary motion; they circulate round and between the protons of the atom, are replaceable by other electrons and ether-particles and can jump from atom to atom and in certain circumstances can be projected from the atom.

Ether-particles are smaller material particles with motions like gas molecules, their mean speed greater than that of light, and can be transmuted into electrons in the atomic mill; as a result their translatory velocity will in general be smaller, their rotatory velocity on the contrary greater. By this means a difference in the ether motion towards and away from the atom is produced—gravitation!

March, 1928.

Bergen op Zoom (Holland).

AN ATOMIC MODEL FOR THE CHEMIST, VIII.

By FLORENCE LANGWORTHY.

With the New Year, it would, perhaps, be as well to sum up briefly what has already been written in these articles.

The positive proton is the electrical equivalent of the negative electron, but if its atomic weight is equal to that of the hydrogen atom minus an electron—as we are told it is—then it is far from being an equivalent in this other important respect. The hydrogen atom is "about 1850 times as massive as the electron." This apparently indicates that the electron is only the electrical equivalent of the proton because the latter contains a positive charge in excess. Let us, for instance, picture a true equivalent to the negative electron—a positive electron of the same infinitesimal atomic weight. Then if the proton contains three of these positive electrons and two negative electrons, it will be positive—as we find—and the addition of another negative electron will make it the neutral hydrogen atom. For there will then be three negative electrons to three positive electrons. And the addition of still another negative electron will make it a negative hydrogen atom since there will now be a negative electron in excess. It was Sir Ernest Rutherford who made this discovery that the neutral hydrogen atom holds up one electron while the negative hydrogen atom holds up two. But the neutral hydrogen atom can sometimes have its electron at such a distance from it as to make it appear a positive and, apparently, act as a positive to any atom that comes between it and its distant electron.

The building up of nuclei would therefore seem to make for an excess of positivism in the same. It is not, therefore, surprising to find, as it were, an excess of negative electrons. If matter is built up in the way described there would be these negative electrons "left over," even if there are in the universe, as we should expect, the same number of each kind. Thus the positive electron may well be elusive with an excess of them locked up in the nuclei. And those that are free may well be very difficult to detect. The air, for instance, instead of insulating them as it does negative electrons, will—since it is composed of two negative gases—help them to escape to earth. While we may picture—in static electricity —the excited positive atoms, with their comparatively heavy weight, as being held in position by their less excited companion-atoms, the positive electrons, with no weight to speak of, will get away. On the other hand the negative electrons are held up by the air and might as well have the weight of negative atoms, so far as getting away through the air is concerned. When, however, thre is moisture in the air the molecule of water vapour, with its excess of positivism, will aid and abet their escape. Still another reason may be adduced for the scarcity of the positive electrons, and that is that when one of them is excited there will

be a rush of negative electrons to join up with it since it will be more attractive to them—as a pure positive—than even the proton. So the positive electron will go to the formation of a neutral or negative particle. We are hearing a good deal about the supposed existence of a sub-electron nowadays. I venture to think that the negative particle is responsible for this and that the "cathode particle" is really a negative particle, while the negative electron, pure and simple, makes its appearance in photoelectricity. For taking into consideration the intense repulsion pure negatives would have for one another, it is rather strange that they should form a stream—as in the "cathode rays"—unless there were positives among them to modify their negativism. It may well be doubted whether two pure negative electrons would remain in each other's vicinity unless there were a positive electron to unite them, or unless considerable force were used. It is improbable that a glass tube would contain a number of them.

We saw that the neutral hydrogen atom sometimes has its negative electron at such distance from it as to make it, to all intents and purposes, a positive atom. For when this is the case any atom coming between the nucleus and its distant electron would be brought into contact with the positive nucleus. Thus we pictured a negative oxygen atom as joining up with such a positive and thereby repelling—as a negative—the electron to a still greater distance. In this way we could understand the explosive energy of the union between the negative oxygen atom and the positive hydrogen atom. The latter would thus be a positive with an electron at a considerable distance comparatively. But even the ordinary neutral hydrogen has its electron at a fair distance and this fact points to the presence of negative electrons in the nucleus—as we have postulated. For if the nucleus is a pure positive, why should the electron remain afar off? The electron is, apparently, forced to keep at a distance. From this distance we pictured it as pulling upon the positive nucleus and thereby giving rise to the weight of 1. If two electrons are thus pulling upon the nucleus—as in the negative hydrogen atom—then the atomic weight will be 2. When matter is bombarded by Sir Joseph Thomson, Sir Ernest Rutherford and others, an atom or molecule of hydrogen—it is not known which it is—of weight 3 is obtained. Sir Ernest Rutherford has also succeeded in knocking a proton out of certain atoms. These facts and those of radio-activity appear to indicate that, when a single planet leaves the atom, it does so as an X-ray, which, on passing out of the ray state, becomes a hydrogen atom of atomic weight 3. On losing one electron, this will become the ordinary negative hydrogen atom with two electrons, and on losing another it will become the neutral hydrogen atom with one electron. If in the bombardment all its electrons are shot away from it so that it is a true proton—not an apparent positive with a remote electron—then we can understand that it will speedily unite with a negative hydrogen atom, the pair making a neutral molecule of hydrogen of atomic weight 2, since they will be sharing the two electrons of the erstwhile negative atom. On the other hand, when a double planet leaves the atom it will do so as an Alpha ray, which on passing out of the ray state, will become a helium atom of atomic weight 4. As the H_3 atom would, in all probability, soon lose its outermost electron, the fraction in the weight of hydrogen would be due to the negative hydrogen atoms that are not linked up with protons. Dr. Aston has shown us that when there is a fraction in the atomic weight it arises from the presence of isotopes. Here the hydrogen molecules, each containing two atoms have the weight of 2. The neutral atom and the positive atom with the distant electron, each has the weight of 1, so there remain the negative atoms with two electrons to form the fraction.

We pictured a positive electron as holding up two of the abundant negative electrons and so becoming a negative *particle*, not atom. In this case the weight would still be infinitesimal since the positive is a pure positive; there is nothing to keep the electrons at a distance. The outer negative electron of the two has united with a pure neutral and so, although the inner one may repel it slightly, there will be nothing like the repulsion experienced by the outer electrons of the negative hydrogen atom, where there would be two inner electrons repelling them. So there will be no "pull" to speak of and the weight will be like that of an electron-infinitesimal. We compared this "pull" to the stretching of elastic. When the negative electrons can remain near the positive, then the elastic is apparently unstretched, but as soon as they are forced away from it by the presence of other negative electrons then the elastic is stretched—in other words, weight comes into existence.

We also pictured the formation of a helium atom. In a sudden rush of these negative particles to unite with an ionised

positive electron, we imagined the positive —attracted by the whirling electrons of a *negative particle—as being in the act of* uniting with the same, when another negative particle is repelled by its fellow negatives into too close a proximity with the uniting pair with the result that its *electrons are shot off to a comparatively*, considerable distance. For within the orbit of the whirling positive is the negative particle. Thus instead of there being merely a negative particle with a positive revolving about the same, there will be an atom of some size, for now there will be two positives revolving about the central particle and also two electrons—at a distance. And this atom will have the atomic weight of 4, since there will not only be the two distant electrons—separated from their positive—but the effect of the two positives upon the inner electrons will be to draw them away from the negative particle while repelling its positive body (its positive electron). Therefore, the negative particle will also become a positive pulling upon two distant electrons. When *it loses those two outer electrons* (when, for instance, it becomes an Alpha particle) its weight will go down to 2 and it will be a double-positive. We pictured two positive electrons in the proton, but they were *separated* by a negative particle and so did not have a double-positive effect upon other atoms. For the short space of time that the helium atom is an Alpha particle the two positive electrons (the double-positive) will be brought into contact with the outer world and, in spite of the repulsion that keeps them wide apart will continue to revolve about the central particle with its two negative electrons that they have drawn away from it. As a double-positive, however, the Alpha ray will soon attract a negative particle and settle down into becoming an atom of helium again. But this time it will, apparently, be an atom of yellow helium, whereas when it had two outer electrons instead of a negative particle it was apparently an atom of green helium. Its atomic weight, nevertheless, will be 4 again since the double-positive within it will be drawing the negative electrons away from the newly-captured negative particle and repelling its positive electron.

It would seem, therefore, that although the green helium atom may be born with outer electrons it is impossible to acquire them once it has lost them and it has to content itself with a negative particle in their place. We can understand this if we take into consideration the intense repulsion of the inner negatives that has kept the outer ones at such a distance. Once their *positive has lost its hold upon them* they cannot be replaced by pure negatives. Only a negative particle—the which contains a positive body—is tolerated by the inner negatives.

(To be concluded.)

ACTION OF THIONYL CHLORIDE ON ORGANIC ACIDS.

By L. McMaster and F. F. Ahmann.

(Reprinted from the Journal of the American Chemical Society, L, 145 (1928).)

Thionyl chloride is a reagent which has become very important for the synthesis of a large variety of organic compounds. In a recent article by Silberrad, a summary of the work upon thionyl chloride is given. It is mentioned as a chlorinating and dehydrating agent, as a reagent for the removal of hydrogen from mercaptans, as a condensing agent and as a catalyst. The most frequent use of this reagent is for the conversion of an acid into its chloride, since it is easier to handle than phosphorus pentachloride. This investigation was begun some months previous to the review by Silberrad and had for its object a systematic study of the reaction of thionyl chloride on organic acids.

Experimental Procedure.

Pure acids in quantities of 15 to 25 g. were treated with two or three times their weight of pure thionyl chloride. In some cases the reaction took place immediately but usually the mixture had to be refluxed with stirring at the boiling point of the thionyl chloride to complete the reaction. In a few cases several days' refluxing were required. In most cases the acid dissolved in the thionyl chloride and a solvent was unnecessary. When a solvent was required, benzene, ether, petroleum ether, gasoline, pyridine and other inert solvents were tried. Since the by-products of the reaction are gaseous, they were readily removed and any excess thionyl chloride was distilled off. Usually the thionyl chloride replaced the OH group by Cl, forming an acid chloride, but in some cases with the dibasic acids anhydrides were formed. These products were purified either by vacuum distillation or by crystallisation. In cases where acids were found not to react, various catalysers such as pyridine, aluminium chloride and iodine were tried.

TABLE I.

SUBSTITUTED ACETIC ACIDS.

Acid.	Amt. in g.	Time hours	Product.	% Yield
			Monochloro-acetyl chloride ...	55
Chloro-acetic ...	15	24	None	—
Trichloro-acetic ...	15	48	None	—
Amino-acetic ...	12	12		

The three negative chlorine groups in trichloro-acetic acid evidently prevent the formation of an acid chloride. With the amino-acetic acid a reaction took place and the thionyl chloride turned intensely red but we were unable to isolate any products of the reaction. It is probable that the amino group was attacked.

TABLE II.

ALIPHATIC DIBASIC ACIDS.

Acid.	Amt. in g.	Time hours	Product.	% Yield
Oxalic	15	72	None	—
Malonic	15	2	Malonyl chloride	60
Succinic	20	6	Succinic anhydride	78
Glutaric	15	6	Glutaric anhydride	78

It was thought that thionyl chloride might react with diethyl oxalate to form oxalyl chloride, but no reaction too place upon refluxing the mixture for forty-eight hours. This is the only method by which malonyl chloride can be prepared, since phosphorus pentachloride converts malonic acid into carbon suboxide. It is a liquid which distils at 55° (15 mm.) and turns dark red on standing. The literature records that succinic anhydride can best be made by this method. Suberic and sebacic acids are reported as forming dichlorides.

THE HYDROXY ACIDS.

The action of this reagent on the hydroxy acids has not been studied very extensively. Malic acid is mentioned as formin a dichloride, while no reference is made to tartaric acid. Lactic acid yields a variety of products. Tartaric acid is the only one of this group studied by us. 15 g. of the acid was refluxed for several days with 40 cc. of thionyl chloride without any result. No suitable solvent for the acid could be found in which to carry out the reaction.

UNSATURATED DIBASIC ACIDS.

Fumaric, mesaconic and bromomaleic acids are described as forming dichlorides, while maleic, citraconic and itaconic acids form anhydrides. We obtained a 90 per cent. yield of maleic anhydride but could not get fumaric acid to react. Benzene, petroleum, ether and pyridine were used as solvents without success. We intend to repeat the action of thionyl chloride on the other unsaturated dibasic acids mentioned, since our work does not agree with the results given in the literature.

TABLE III.

SUBTITUTED BENZOIC ACIDS. 15 g. of Acid used in each case.

Acid.	Amt. in g.	Time hours	Product.	% Yield
o-Nitrobenzoic ...	...	3	*o*-Nitrobenzoyl chloride ...	90
m-Nitrobenzoic ...	...	3	*m*-Nitrobenzoyl chloride ...	86
p-Nitrobenzoic ...	...	6	*p*-Nitrobenzoyl chloride ...	78
o-Aminobenzoic ...	...	3	None	
m-Aminobenzoic ...	...	3	*m*-Aminobenzoyl chloride ...	83
p-Aminobenzoic ...	...	4	*p*-Aminobenzoyl chloride ...	88

Heumann and Koechlin studied the action of thionyl chloride on benzoic acid. We obtained a 98 per cent. yield against one of 90 per cent. by the phosphorus pentachloride method. Meyer has prepared by this method the *p*-nitrobenzoyl chloride after a long period of refluxing. We found that it was the most difficult of the three to prepare.

Phosphorus pentachloride cannot be used to prepare an acid chloride of an aminobenzoic acid since it attacks the amino group. We could find no references to the acid chlorides of the aminobenzoic acids. In the case of the *o*-aminobenzoic acid a vigorous reaction too place when it was first treated with the thionyl chloride and it was necessary to surround the flask with a freezing mixture. We were not able to isolate any definite products of the reaction. The *m*-aminobenzoyl chloride is a yellow oil distilling at 125° (15 mm.). Upon standing it passes into a solid of m.p. 42° and possesses a decided acid chloride odor. It reacts vigorously with water, ammonia and alcohol. Analysis gave 22.72 per cent. of chlorine whereas the calculated value is 23.44 per cent. The *p*-aminobenzoyl chloride is also a yellow oil distilling at 120° (12 mm), solidifying upon standing to yellow crystals of m.p. 31°. These crystals possess the same properties as the meta compound and were found to contain 22.62 per cent. of chlorine.

The Hydroxybenzoic Acids.

In only exceptional cases have the acid chlorides of the hydroxybenzoic acids been prepared by ordinary methods. When phosphorus pentachloride is used as a chlorinating agent, the OH group is also attacked. Meyer found that salicylic acid, *m*-hydroxybenzoic acid and *o*-and *m*-cresotinic acids readily formed the acid chlorides with thionyl chloride. We were able to obtain by using the free acid only a very small yield of the acid chloride of salycilic acid but a 36 per cent. yield was obtained by using the sodium salt of the acid. The salicylyl chloride is a white, crystalline substance melting at 18° to a colourless, syrupy liquid which distils at 90° (11 mm.). No yield of the acid chloride could be obtained with *m*-hydroxybenzoic acid nor with *o*-and *m*-cresotinic acids as claimed by Meyer. We obtained only glassy solids of indefinite composition. The para acids do not react. Meyer states that an acid chloride is not formed if the acid has an OH group in the para position unless a second OH group is in the ortho position with respect to the first OH group.

The Phthalic Acids.

The phthalic acids have been studied previously by Meyer, who found that phthalic acid formed an anhydride, isophthalic acid a dichloride and terephthalic acid was unattacked. Since no yields were recorded they were reinvestigated.

Table IV.

Acid.	Amt. in g.	Time hours	Product.	% Yield
Phthalic	20	2	Phthalic anhydride	95
Isophthalic ...	10	12	Isophthalyl chloride	62
Terephthalic ...	15	72	None	—

Attempts to prepare phthalyl chloride were made by prolonged boiling of the anhydride with the thionyl chloride using aluminium chloride ,iodine and pyridine as catalysts but without success. The isophthalyl chloride is a colourless oil distilling at 200° (15 mm.). Catalysers and various inert solvents were tried in the attempt to prepare terephthalyl chloride.

Summary.

Thionyl chloride readily converts the acids of the fatty acid series into acid chlorides. Chloro-acetic acid is converted into an acid chloride while trichloride-acetic and amino-acetic acids are not.

Of the dibasic acids, oxalic is unattacked, while succinic and glutaric yield anhydrides and malonic ,suberic and sebacic acids form dichlorides.

Tartaric acid is unattacked.

Of the unsaturated dibasic acids employed, maleic forms an anhydride and fumaric acid is unchanged.

Of the benzoic acids, the three nitrobenzoic acids all form the acid chlorides. The *p*-nitrobenzoyl chloride is formed only with difficulty due to the presence of the negative nitro group in the para position. Acid chlorides of *m*-and *p*-aminobenzoic acid can be prepared by this method. The ortho acid does not form an acid chloride.

Only by the use of thionyl chloride can the acid chlorides of some of the aromatic hydroxy acids be prepared. *o*-Hydroxybenzoic acid forms an acid chloride while the para acid does not. *m*-Hydroxybenzoic acid and the cresotinic acids gave products which could not be identified as acid chlorides as stated by Meyer.

Of the phthalic acids, the ortho acid forms an anhydride, the meta acid a dichloride and the para acid is not attacked by thionyl chloride.

The action of thionyl chloride on other organic acids is being continued.

GENERAL NOTES.

GOODWILL IN INDUSTRY.

The first Joint Committee for the consideration of the Agenda for the Industrial Conference between the General Council of the Trades Union Congress and the Representative Group of Employers, was held on Wednesday, March 21, 1928, at the apartments of the Royal Society, Burlington House, Piccadilly, W.1.

Sir Alfred Mond was voted to the chair on the proposition of Mr. Ben Turner, Chairman of the General Council of the Trades Union Congress. Sir Alfred Mond proposed that the chair should be occupied at the next Joint Committee Meeting by Mr. Ben Turner and subsequently by alternate chairmen. This was agreed to.

There were present :—Sir Alfred Mond, Mr. Ben Turner, Sir David Milne-Watson, Lord Londonderry, Lord Ashfield, Colonel Vernon Willey, Mr. George Hicks, Mr. W. M. Citrine, Mr. Arthur Pugh, Mr. Ernest Bevin, Mr. Tom Richards, Mr. Will Thorne, and Mr. Conway Davies and Mr. W. Milne Bailey, Secretaries. Apologies were received from Lord Weir and Sir Hugo Hirst for their absence as they were abroad.

The question of the Agenda was discussed fully and it was decided that the Agenda agreed by the Joint Committee should be referred respectively to the General Council of the Trades Union Congress and the Representative Group of Employers. It was arranged that for the consideration of the various items of the Agenda that further Joint Committee Meetings should be held weekly.

In view of the large field of industrial problems covered by the Agenda and the importance of those problems, it was agreed that some lapse of time must occur before any complete and detailed information could be communicated to the Press. Arrangements will be made for further full Joint Conferences as required.

THE ELECTRO-REDUCTION OF ORGANIC SUBSTANCES.

In a series of papers Dr. M. Shikata and his collaborators (*Memoirs of the College of Agriculture*, Kyoto Imperial University, Japan, 1927, No. 4) have given an account of some electrochemical investigations with the dropping mercury cathode. The reduction potentials of reversible and irreversible reactions can easily be measured in a [illegible] the other electrolytic methods such as that of Conant (*J. Amer. Chem. Soc.*, 1922, XLIV., 2480), who took as a measure of reducibility the presence of an interaction between the compound of the irreversible type in question and a series of eight reducible compounds of known R.P.

In the first article of this series the experimental arrangement of the measurements with the dropping mercury cathode and the Heyrovsky-Shikata polarograph are described (*Rec. trav. chim.*, 1925, XLVI, 496) and the theoretical meaning of the observed reduction curves is explained.

The reduction of iso-valeraldehyde (H. by Shikata and I. Tachi) proceeds reversibly in both acid and alkaline solutions. The behaviour of the reduction potentials in neutral solutions seems to indicate the negative adsorption of iso-valeraldehyde at the mercury cathode.

The polarisation curves of pyridine (*ibid.*) exhibits two reduction stages. The first is assumed to be due to the reduction of the pyridine ion and the second to the reduction of the undissociated pyridine molecules. Thus, there is a difference in reducibility between ionised and unionised pyridine molecules. The reduction apparently proceeds irreversibly. The electrolytic reduction of nicotinic acid proceeds also in two stages. The first stage corresponds to the reversible reduction of the carboxyl group of nicotinic acid to the corresponding aldehyde. The second stage is considered to be the reduction of the pyridine ring by comparison with the reduction potentials of pyridine. In alkaline solutions nicotinic acid is not reduced. The polarisation curves show a maximum of current which is connected with the adsorption of the acid at the electrode surface.

The polarographic method was applied to the microanalysis of lead in the ash constituents of cerebrospinal fluid poisoned with lead (V. Shikata, Tachi and Hozaki) and proved to be useful in the estimation of traces of copper in canned green peas. The results agreed with those obtained by ordinary analysis.

Dr. M. Shikata also deals with the formation of complex copper salts. The equilibrium constant was calculated in copper and lithium chloride solutions, and found to be 8.98 × 10^{-9} for the equilibrium :—

$$Cu^{++} + 3Cl' \rightleftarrows CuCl'_3$$

For the system $CuSO_4$ - $MeSO_4$ the effect of the sulphate concentration was less conspicuous than in the chloride complex.

The polarographic method has been applied to the microanalysis of reducible substances in Japanese fermentation products (sake, shoyu, wine and beer) and to the estimation of impurities in commercial isoamyl alcohol.

WHOLESALE PRICES IN FEBRUARY.

Board of Trade Index Number.

As measured at the Board of Trade, wholesale prices were somewhat lower, on the average, in February than in January, the index numbers for the two months being 84.4 and 84.9 respectively (1924 = 100). The average for the three food groups shows a fall of 1.1 per cent., and meat and fish by 4.9 per cent., comparing the average of February prices with figures for January, while miscellaneous foods became dearer by 1.8 per cent. The February index for the five groups of industrial materials is lower than the January index by 0.5 per cent. The greatest price movements were in textile materials, cotton showing a fall of 2.3 per cent., and other textiles a rise of 1.7 per cent. The averages for metals and minerals other than iron and steel, and for miscellaneous materials indicate reductions of 0.6 per cent. in each of those two groups. Slight changes in both directions in iron and steel prices in February resulted in the index remaining the same as that for January.

CITY'S WAR ON SMOKE.

The Manchester Corporation is setting an example to citizens in regard to smoke abatement.

According to Mr. R. M. Rowe, Technical, Chemical and Smoke Inspector to the Corporation, experiments have recently been made at the Town Hall in the use of coalite, the smokeless residual fuel of low temperature carbonisation, in open grates, and these are now to be repeated on an extended scale.

It is understood that there will be a three months' trial at the Town Hall, in civic buildings and in the hospitals.

GAS HEATING IN THEATRES.

Specially Designed Radiators for the New Palladium.

The practice of heating theatres and other large buildings by specially-designed gas radiators appears to be growing.

Recently a number of these appliances, known as the "St. Martin," manufactured by John Wright & Co., of Birmingham, were installed in the Capitol Picture Theatre, Haymarket, S.W., and now the Gas, Light and Coke Company have a contract in hand to fix no fewer than 79 of these radiators, finished in old gold, in the vestibule and auditorium of the Palladium Theatre, W., which has now re-opened as a "cine-variety" house.

The "St. Martin," which has been approved by the London County Council for public buildings, is automatically controlled to maintain an unvarying temperature in the hall, corridor, or apartment in which it is placed, and has been designed to avoid the necessity for a flue when used in large buildings. The burner is totally enclosed, and is lighted by means of a special aperture which is automatically sealed by the closing of a small circular plate. Coloured glasses in the base of the radiator show when the burner is alight.

OIL FROM COAL.

Interesting information on the progress of low temperature carbonisation was given by Commodore H. Douglas King, Secretary for Mines, in the House of Commons on Tuesday, March 13, in reply to a question by Mr. David Grenfell.

"There are now," he said, "five plants each designed for a throughput of 100 tons a day or more in working order in this country, and there are some six or eight further systems with a capacity of 10 tons a day or over. These include the type developed at H.M.'s Fuel Research Station, of which a 100-ton-a-day plant is being erected by the Gas, Light and Coke Co.

"The results obtained from these plants during the next few years should show how far, and under what conditions, each type is likely to be a commercial success."

According to information supplied to the recent Carbonisation Conference, under the process in operation at Barugh, near Barnsley, 1,500 tons of coal are being carbonised weekly, yielding over 1,000 tons of coalite, 28,200 gallons of oil, 3,750 gallons of benzole, and 7,000,000 c.f. of rich gas.

TRANSFORMATION OF MATTER.

At the Royal Institution, London, on March 10, Sir Ernest Rutherford delivered an address on "The Transformation of Matter." It was well-known he said, that minute traces of gold were to be found in many substances, and where gold was said

to have been produced from base metals, the gold was no doubt there all the time. In the last few years the Press had been full of claims by people that they could change mercury or lead into gold or some other metal. The first case was the conversion of mercury into gold by the passage of electric current through an ordinary mercury vapour. This claim had been made within recent years by German and Japanese scientists, and much about this miracle has appeared in the newspapers. Actually, the minute amounts of gold thus "transmuted" were present to begin with either in the mercury or the electrodes, for when other experimenters had carried out precisely the same experiment after having first taken the precaution of removing all foreign substances from the materials used, not a trace of gold was produced.

The theory of the permanency and indestructibility of the atom was, until the end of last century, the foundation of chemical and physical science. Then came the sensational discovery of radium and other radio-active substances, which had revolutionised all ideas of the atom and the structure of matter. The study of the transformations which occurred in these radio-active bodies was one of the most fascinating branches of science. Before one's eyes these substances could be seen transforming themelves into other substances by ejecting alpha, beta, and gamma particles from their atoms. Up to the present, methods of transmuting metals on any large scale were not proved. At the same time they could not say that it might not become possible on a small scale to produce those effects.

NORTH-EAST COAST EXHIBITION OF SCIENCE AND ART.

It is 40 years since the last Newcastle Exhibition closed in a triumphant success. It is now proposed to hold an exhibition from May to October, 1929. Already the preliminary announcement contains a list of influential patrons and supporters, which augurs well for the success of the great under taking, which cannot fail to have far-reaching beneficial results on the various industries in the North and also the whole country. The Offices of the Exhibition are at Pearl Buildings, Northumberland Street, Newcastle-upon-Tyne, the Hon. Secretary being Mr. Herbert Shaw, D.L., J.P., and the Organiser and General Manager, Mr. C. P. Mamsworth.

Proceedings and Notices of Societies

THE ROYAL SOCIETY.

The following papers were read at the meeting held on Thursday, March 1 :—

The Hexahydrated Double Sulphates Containing Thallium. By A. E. H. TUTTON, F.R.S.

Since the paper read to the Society in 1922, in which the work on the large isomorphous series $R_2M\left({}^{S}_{Se}O_4\right)_2.6H_2O$ was brought to conclusion so far as the potassium, rubidium, cæsium, and ammonium salts of the series were concerned, the author has endeavoured to obtain the corresponding thallium salts of the series, two of which only had been included in the work published, the other twelve salts having proved too difficult to obtain in adequately good crystals. In 1925 two others were obtained and described, and the author has now succeeded in obtaining excellent crystals of the remaining ten. Four of them are double sulphates containing thallium as the R-metal, and magnesium, ferrous iron, manganese and copper as the M-metals. These are described in the present communication. The other six are double selenates, and are described in the following memoir.

The Hexhydrated Double Selenates Containing Thallium. By A. E. H .TUTTON, F.R.S.

The six salts are those in which R- is thallium and the M-metal is magnesium, nickel, cobalt, ferrous iron, manganese, and copper.

The results of the whole investigation (both papers) agree in showing that while, as previously proved, potassium, rubidium, and cæsium salts of the great series invariably show crystal forms and properties which vary regularly with the atomic number of the alkali metal, and that the ammonium members, while showing no relation to atomic numbers or weights, resemble the corresponding rubidium salts containing the same M-metal so closely as to be practically iso-structural, thallium salts invariably occupy a position well within the limits (as regards angles and constants) of potassium and cæsium salt, and one which approaches most closely to that of the rubidium salt, yet not so closely as do the ammonium salts. Thallium salts, however, have one strikingly outstanding property, that of very high optical refraction, occasionally exceeding even that of monobromo-

naphthalene and yet more so that of carbon bisulphide.

These papers complete the author's study and full detailed description of the great series of seventy-seven salts.

The Distribution of Intensity in the Band Spectrum of Helium : the Band λ 4650. By W. H. J. Childs. Communicated by O. W. Richardson, F.R.S.

Some measurements of the intensity distribution in the helium band λ 4650 .(first of the main series) are given enabling the predictions of the summation rule to be tested. The predicted distribution is of the correct type, but agreement with observation is by no means complete. Notably the P and R′ branches are much stronger, relative to the Q branch than theory indicates. It is found that an expression, of form $ic^{-E/kT}$ where i is a linear function of j', is adequate to describe the observed distribution.

As with many other bands the temperature obtained by assuming that distribution of angular momentum is governed by the Boltzmann factor is much higher than the true temperature of the gas. In this case effective temperatures or approximately 750 A and 1000 A are found, depending on conditions of excitation. A higher temperature is obtained from the Q branch than from the P and R branches. Examination of Doppler width of band lanes shows, however, that there is a distribution of translational velocities corresponding to true temperature.

Studies in the Behaviour of Hydrogen and Mercury at the Electrode Surfaces of Spectrum Tubes. By M. C. Johnson. Communicated by S. W. J. Smith, F.R.S.

The proportion of a hydrogen positive ray spectrum which is due to the neutralisation of protons is decreased by a temporary admission of Mercury vapour. The decrease persists after the Hg is pumped off and the tube repeatedly washed with H. The accompanying domination of the spectrum by Hg at an extremely small partial pressure is delayed and weakened by the substitution of Nickel for Aluminium as the cathode material, except when the Ni is kept in gaseous communication with Al.

The resistance at electrodes of different sensitivities to Hg contamination is not altered by that contamination if the tube is filled with H, but is sensitive to a change from H to air. Hg is only liber ated from a contaminated cathode during discharge. When Hg is admitted to a tube the rise in total gas pressure continues after the Hg admission has ceased.

A solid Hg cathode can be made to disintegrate under bombardment in a manner different from its thermal evaporation, but the excessive disintegration product of the contaminated Al is of Al and not due to thermal or electrical sputtering of Hg.

These results can be related to other known facts by a hypothesis that the increased cathode disintegration is not, as on current theories, a primary effect of the admission of a monatomic gas. Instead we suppose, it is the secondary effect of the removal of a surface layer of Oxygen, allowing disintegration afterwards by ordinary proton bombardment, and allowing escape of H from the Al structure. The spectrum changes are then cousequences of mass and critical potentials of Hg. The resistance experiments indicate that alternative explanation by inhibition of photo-electric liberation at cathode by Hg is not required for the positive ray experiments.

SOCIETY OF PUBLIC ANALYSTS.

The Annual General Meeting of the Society was held at the Chemical Society's Rooms, Burlington House, on Wednesday, March 7, when the President, Mr. E. Richards Bolton, delivered his annual address.

The following were elected as Officers and Council for the year 1928 :—

President— Edward Hinks.

Past Presidents, serving on the Council— E. Richards Bolton, A Chaston Chapman, Bernard Dyer, P. A. Ellis Richards, Alfred Smetham, G. Rudd Thompson, E. W. Voelcker, J. Augustus Voelcker.

Vice-Presidents — John Evans, Thomas Macara, John White.

Hon. Treasurer—E. B. Hughes.

Hon. Secretary—F. W. F. Arnaud.

Members of Council—A. P. Davson, J. Golding, J. T. Hewitt, E. V. Jones, R. Lessing, Andrew More, W. Partridge, E. K. Rideal, W. H. Roberts, C. A. Seyler, M. S. Salaman and Jas. Wood.

An Ordinary meeting of the Society then followed, the President, Mr. Edward Hinks, being in the chair.

Certificates were read for the first time in favour of Frank Rowland Hill, B.Sc., A.I.C., Edward Thomas Illing, B.Sc., F.I.C.; Farid Isander, Harry Bulmer Marston, B.Sc., A.I.C.; Reginald James Munro, B.Sc., A.I.C.; John Ralph Nicholls, B.Sc., F.I.C.; H. Gordon Reeves, D.Sc., Ph.D., F.I.C.; George Walsh, B.Sc., A.I.C.; Ronald

George Warren, B.Sc.; William Arthur Waygood, B.Sc., A.R.C.S., A.I.C.

Certificates were read for the second time in favour of: John Edmund Aps, Edward Eric Billington ,M.Sc.; Ralph C. Chirnside; Ralph David Owen, A.I.C., A.M.I.Chem.E.

The following were elected Members of the Society: Andrew R. Buchanan and Arthur George Francis, B.Sc., F.I.C.

The following papers were read:—

Composition of the Fatty Acids present as Glycerides in Elasmobranch Oils. By T. P. HILDITCH, D.Sc., F.I.C., AND A. HOULBROOKE.

The method of separating the fatty acids of shark-liver oils by fractional distillation of the methyl esters has been experimentally examined, and identification tests applied to the redistilled fractions have established the validity of the method. The results are probably accurate to within about 1 per cent., up to and including acids of the C_{20} series. It is shown that whereas normal marine animal oils contain 30 to 40 per cent. of acids of the C_{20} and C_{22} groups, the fatty acids of shark-liver oils are of relatively low unsaturation. Apparently there is some connection between the deficiency of the above-mentioned highly unsaturated acids and the presence of large amounts of the highly unsaturated squalene.

Behaviour of Indicators in the Titration of Ammonia, Sodium, and Calcium Phosphates, the Methylamines, Pyridine Bases and Boric Acid. By R. T. THOMSON, F.I.C.

A series of determinations has been made to ascertain the value of different indicator for the commercia lanalysis of these products. For ammonia and the methylamines methyl orange is the most satisfactory, and Congo Red for pyridine bases. Methyl orange is also to be preferred as an indicator for boric acid in quantities not exceeding 0.2 grm. The difficulties in titrating phosphates are discussed, and the results obtained with different indicators are compared.

Cacoa Tannin. By H. R. JENSEN, M.Sc., F.I.C.

As tannin is probably a principal cause of astringency in chocolate, the cinchonine method has been applied to the determination of tannin in cacoa. The cinchonine tannate precipitate was found to contain 4.4 per cent. of nitrogen, which is similar to the 4.3 per cent. found in the hop and tea tannin compounds. The water-soluble tannin content of eleven samples of fully roasted cacao nibs ranged from 5.2 to 6.3 per cent.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

At the meeting on March 7, at 16, Bedford Square, London, Mr. H. Dent Brocklehurst (chairman) reported that the list of samples analysed for members by the Consulting Chemist for the month of February had been submitted to the Committee. A letter had been received from the Ministry of Agriculture regarding the recently issued Regulations under the Fertilisers and Feeding Stuffs Act, 1926. The Ministry asked that any observations thereon should reach them not later than March 28. The Committee, after consideration, had no observations to make on the draft Regulations. Further correspondence had been reported to the Committee by the Consulting Chemist on the subject of crushed oats. Various matters arising out of Dr. Voelcker's correspondence had been submitted to the Committee.

Mr. Brocklehurst, in moving the adoption of this Report, referred to the Fertilisers and Feeding Stuffs Act, 1926. Provision was made in that Act for the drawing up of regulations, and an Advisory Committee, consisting of members of the trade and the farming and scientific interests concerned, had been studying and framing rules for the purpose. The Draft Statutory Rules now issued by that Committee came before the Chemical Committee on the previous day. The Committee had no suggestions as to alterations in the rules, and he thought he could say the arrangements were very satisfactory. A great many points that the Society had urged for a considerable number of years had been gained, and Dr. Voelcker had worked very well in the interests of agriculturists.

The motion was carried.

GEOLOGICAL SOCIETY OF LONDON.

(*Continued from page* 190.)

The Annual General Meeting was held on February 17, 1928, Dr. F. A. Bather, M.A., F.R.S, President, being in the chair.

You have been good enough to refer with appreciation to my palæontological work. Do you know, Sir, that it was your example when it was not your precept, that showed me how to present a palæontological treatise; and, what is more, taught me all that might be called the scholarship of Palæontology?

You have also kindly approved of my work in the field. It would be strange if any ground touched by the genius of De la Beche, should prove uninteresting. The geology of Charmouth and the Vale of Marshwood has indeed proved of extraordinary interest, largely for the palæontological problems bearing on evolution which it has provided. I do not know whether the tradition of a classic locality and the palæontological problems which its geology provided would alone have been strong enough to monopolise the vacations of a quarter of a century, had they not been reinforced by the alluring charms of that truly delectable country, to which I am partly native.

To-day, Sir, by a strange coincidence of time, you not only leave behind you the Presidency of this Society, but you also retire from the Keepership of Geology; on the same day you not only relinquish to me that Keepership, but you also hand me a Lyell Medal, a lasting and cherished reminder of this unique occasion. I thank you, Sir.

The President handed the balance of the proceeds of the Wollaston Donation Fund to Mr. James Wright.

The President then presented the balance of the Proceeds of the Murchison Geological Fund to Dr. George Slater.

The President handed the balance of the Proceeds of the Lyell Geological Fund (awarded to Mr. Ben Lightfoot) to Mr. W. Campbell Smith for transmission to the recipient.

The President prefaced his Anniversary Address by briefly recalling the chief services to geological science by some of those recently deceased.

Comparing the palæontology of to-day with that of forty years ago, the President laid stress on the change from the static period of descriptive morphology to the dynamic period of physiology and ethology. The two divisions of palæontology in its modern aspect are Biostratigraphy and Palæobiology. Glancing at the former, he turned to the latter and selected for consideration the section of it termed Palethology, which deals with the habits of extinct creatures and the response of both habit and structure to their surroundings. This he illustrated by a few of the many ways in which the fossil stalked Echinoderms reacted to their environment, dealing mainly with the structure of the stereons, the various types of stem, the relations to gravity, the effect of habitat, the modes of feeding, and the sanitary arrangements.

The problem of adaptation was then considered, it being maintained that this underlaid all the main conclusions of Palæontology, such as Dollo's Law of Irreversibility, the Biogenetic Law of Haeckel, Rosa's Law of Progressive Reduction of Variability, and Orthogenetic Trends. The Lamarckian and the Darwinian explanations were contrasted, and it was shown that, in ultimate analysis, the former must depend on the latter. The modification of Darwin's theory, expounded by Cuénot, was held to be in the main just another way of looking at the same facts. Even if the two supposed processes differ, both may operate ou the same population at the same time. Both explanations of adaptation postulate a succession of mutations, and the main question to-day is : Why do mutants so often assume the same character as the adaptive modification? Summing up a discussion of recent theories of mutation, the speaker concluded that if a complex physico-chemical structure were admitted as a basis of variation, and if the irreversibility of the chemical changes in it were allowed, then it seemed to provide that fundamental premiss from which, in combination with a verying environment, all the Laws of Palæontology could be deduced.

The continuous process of adaptation to a constantly changing environment leads to death—death of the individual and death of the race. Families, Orders, and Classes, after reaching the acme of specialised adaptation, have, on that very account, perished and have been succeeded in the procession of life by hitherto humble followers. Man himself has sprung from the ranks, and he, too, is subject to the same laws. Man will perish as a race, and we know not what will succeed him. *Omnes eodem cogimur.*

The Ballot for the Council and Officers was taken, and the following were declared duly elected for the ensuing year :—

Council—Francis Arthur Bather, M.A., D.Sc., F.R.S.; Thomas Crook; Ernest Edward Leslie Dixon, B.Sc.; James Archibald Douglas, M.A., D.Sc.; John Downie Falconer, M.A., D.Sc.; Prof. William George Fearnsides, M.A.; Prof. Edmund Johnston Garwood, M.A., Sc.D., F.R.S.; Prof. William Thomas Gordon, M.A., D.Sc., F.R.S.E.; Edward Greenly, D.Sc.; Prof. John Walter Gregory, D.Sc., F.R.S.; Prof. Herbert Leader Hawkins, D.Sc.; Robert Stansfield Herries, M.A.; Finlay Lorimer Kitchin, M.A., Ph.D.; Horace Woollaston Monckton, Treas.L.S.; John Pringle; James Romanes, M.A.; Walter Campbell Smith, M.C., M.A.; Leonard James

Spencer, M.A., Sc.D., F.R.S.; Prof. Henry Hurd Swinnerton, D.Sc.; Cecil Edgar Tilley, Ph.D., B.Sc., A.I.C.; Arthur Elijah Trueman, D.Sc.; Prof. William Whitehead Watts, LL.D., Sc.D., M.Sc., F.R.S.; and Sir Arthur Smith Woodward, LL.D., F.R.S., F.L.S.

Officers—President—Prof. John Walter Gregory, D.Sc., F.R.S.; *Vice-Presidents*—Francis Arthur Bather, M.A., D.Sc., F.R.S.; Prof. Edmund Johnston Garwood, M.A., Sc.D., F.R.S.; Edward Greenly, D.Sc.; and Horace Woollaston Monckton, Treas.L.S.; *Secretaries* — Walter Campbell Smith, M.C., M.A., and James Archibald Douglas, M.A., D.Sc.; *Foreign Secretary*—Sir Arthur Smith Woodward, LL.D., F.R.S., F.L.S.; and *Treasurer*—Robert Stansfield Herries, M.A.

The thanks of the Fellows were unanimously voted to Dr. F. A. Bather, retiring from the office of President; to Dr. J. W. Evans, retiring from the office of Vice-President (*and also from the Council*); to Prof. J. E. Marr, retiring from the office of *Foreign Secretary (and also from the* Council); and to the other retiring members of Council: Prof. B. C. Illing, Mr. P. Lake, and Mr. T. C. Nicholas.

STUDY OF ATOM AIDS MODERN DEVELOPMENT.

Practical Results from Application of Atomic Theories — Investigations by Astrophysical Laboratory.

The outstanding development of science in the twentieth century has been the increase in knowledge about atoms, the ultimate particles of matter. Physical investigation has shown that atoms are composed of a relatively massive nucleus surrounded by a cloud of electrons. These electrons, therefore, are a universal constituent of all matter, and the investigation of their properties has been a subject of profound scientific interest. Recently at the Dominion Astrophysical Laboratory at Victoria, British Columbia, an examination was made of the mass of the electron and other atomic dimensions from studies of the spectra of some very hot stars. One important result of this investigation was to show that the structure and dimensions of the atom were exactly the same in the hottest and most distant stars as on the earth, an important confirmation of the homogeneity of matter throughout the universe. Thus, by collaboration, largely between physicists and astronomers, the modern comprehensive knowledge of the structure of matter has been built up.

In this respect it may be appropriate to recall how this knowledge has reacted upon the practical life of the community. Modern developments in certain improved X-ray tubes which have revolutionised medicine and certain branches of industry have come directly from an application of modern atomic theories. Again, the recent almost miraculous growth of radio broadcasting and reception is due largely to research on atomic structure.

These important inventions, to say nothing of the modern developments in the reproduction of music, the detection of icebergs by heat rays, and other more or less important devices, are all the outgrowth of modern knowledge of atomic structure, in short these integral parts of present-day civilisation are due to research in physics and astrophysics alone.

FORTHCOMING EVENTS.

GEOLOGICAL SOCIETY.

Burlington House, London, W.1.

Wednesday, April 4, at 5.30 p.m.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

At the House of the Royal Society of Arts, John Street, Adelphi, W.C.2.

Tuesday, April 3, at 5.30 p.m.—" The Oil Well and Later Developments at Hardstoft, Derbyshire." By Arthur Wade, D.Sc., A.R.C.Sc., M.Inst.P.T., etc.

SOCIETY OF PUBLIC ANALYSTS.

The next meeting of the Society will be held on Wednesday, April 4, at the Chemical Society's Rooms, Burlington House, Piccadilly, W.1., at 8 p.m.

The following papers will be read:—

" Coffee Parchment as an Adulterant of Bran and Sharps." By John Evans, F.I.C., and T. E. Wallis, B.Sc., F.I.C. " Determination of the Colour-producing Constitu-

ents of the Cacao Bean." By W. B. Adam, M.A., F.I.C. "Determination of Vanadium in Steel." By A. T. Etheridge, Ph.D., F.I.C. "Colorimetric Determination of Antimony and its Separation from Tin." By S. G. Clarke, B.Sc., A.I.C. "Determination of Carbon Dioxide in Soils." By A. Riad, B.Sc., Ph.D.

NOTICES OF BOOKS.

Directory of Paper Makers, 1928. Pp. 272. London: Marchant Singer & Co., 47, St. Mary Axe, E.C.3. Price 5s. 6d.

The 1928 issue of this important trade *Directory* is the 52nd annual publication. It has been authentically revised and brought up to date for many changes have occurred in the last twelve months.

It includes lists of mills, paper makers, agents, enamellers, gummers, etc., trade customs, designations and standards and other information of general interest.

Fundamentals of Dairy Science. By the Associates of Dr. Lore A. Rogers in the Bureau of Dairy Industry, U.S.A. Department of Agriculture. Pp. 544. Price $5.50. New York: The Chemical Catalog Company, 419, Fourth Avenue, at 29th Street, New York, U.S.A.

This work (one of the American Chemical Society Monograph Series) deals in both a scientific and practical manner with one of the most important industries of the world. Intended in the main as a handbook for advanced students, it yet appeals to a much wider circle of readers. It is in fact a book that ought to find a place in the home of all persons connected with the dairy industry. It consists of fifteen chapters, each of which deals fully with some particular phase of the subject. Thus, Chapter I tells all about milk, while Chapter XV deals with the physiology of milk secretion.

Science for You. By J. G. Crowther. Pp. 242. Price 5s. net. London: George Routledge and Co., Ltd., 68-74, Carter Lane.

A very common complaint made by the general public against scientific men is that their explanations of the mysteries of science render the mysteries still more mysterious, instead of elucidating them. This charge cannot be levelled against the present author, whose efforts at simplification in a series of well-written essays have been successful, inasmuch as he practically steers clear of science and its abstruse formulæ. There are XII Chapters, commencing with Earth, Air, Fire and Water, and ending with Opinions, Science and Journalism.

Nitrate Facts and Figures, 1928. Compiled by A. H. Brodie James, F.S.S. Price 5s. net. London: Matheson and Sons, 15, Copthall Avenue, E.C.

This is a handy, reliable tabular work, which gives all the salient information required about the nitrate industry and the large number of companies engaged in the industry. We notice that an agreement among the various producers to restrict output came to an end in April, 1927. Within nine months, consumption had reached 2,650,000 tons at about 17s. 6d. per ton. We learn there are now 65 oficinas producing some 3,000,000 tons per annum, while some 86 oficinas remain in a state of suspended animation. We notice in the column reserved for dividends in the statement relating to the companies, the most popular word is "nil."

NEW GERMAN BOOKS.

Allgemeine Petrographie der "Olschiefer" und ihrer Verwandten. By Dr. R. Potonie. Pp. 174. 1928. Price 12 marks.

Uber Konstitution und Zusammenhange in der Sesquiterpene. By Dr. L. Ruzicka. Pp. 56. 1928. Price 4m. 80pf. Berlin: Gehruder Borntraeger.

Both Dr. Robert Pontonié and Dr. Ruzica are authorities in the subjects upon which they have written and specialists in the branches of organic and applied chemistry to which their monographs belong will doubtless read these contributions with interest.

Destillieren und Rektifizieren. By Dr. K. Thormann. Pp. vi + 114. Leipzig: Otto Spamer. 1928. Price 12m.

There has hardly been a text book upon distillation which has incorporated the recent theoretical physico-chemical work on phenomena connected with the subject. The author has endeavoured to show how the latest improvements in distillation practice have resulted from such applications of purely theoretical knowledge especially as regards the preparation of spirits from alcoholic liquors. This technological work is characterised by German thoroughness and should commend itself to many physical chemists and industrialists.

Forstschritte in der anorganish-chemischen Industrie. By A. BRAUER AND J. D'ANS. Band 3 1924-7. First Section. Price 36m. Berlin : Julius Springer.

The industries connected with inorganic and heavy chemicals are now being intensively developed on most countries and the technical literature upon current practice and new patents is so great that compilations of this kind are almost indispensable. In their digest of recent advances in industry, the authors have had the assistance of Dr. J. Reitstotter.

The publishers, Julius Springer, have also issued the *Chemiker Kalender*, 1928, price 18m. It follows the plan of the last year but has been extensively revised and constitutes a remarkably valuable, if bulky, "pocket book" in three volumes.

Messrs. T. Steinkopff (Dresden & Liepzig) published vols. xix & xx. in Prof. R. Liesegang's Science Series. They are *Hormone und innere Sekretion* by Dr. F. LAQUER, (pp. 142; price 8m. 50 pfs.)—and *Biologishe Kolloidchemie* by PROF. LIESEGANG (pp. 140; price 8m.). The first presents a concise account of the subject with over 1200 references to the literature. The second, also written for the medical profession and biochemists, deals with the colloidal phenomena in living organisms.

J. G. F. D.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

7,359.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of chlorinated benzene compounds. March 9th.

7,416.—Schieferwerke Ausdauer Akt.-Ges. —Method of producing hexamethylentetramine. March 9th.

6,983.—I. G. Farbenindustrie Akt.-Ges. —*Manufacture of 6-nitro-2-amino-*1-benzoic acid, etc. March 6th.

Specifications Published.

286,115.—Abbot Laboratories.—Arseno bismuth compounds and process of making same.

286,338.—Adler, Dr. O., and Adler, Dr. R. —Method of removing germs from water.

286,358.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of isatins of the naphthalene series.

266,388.—I. G. Farbenindustrie Akt.-Ges. —Obtaining diazosulphamic acids of the cyclic series.

281,227.—Newpoer Co. — Preparing para'-hydroxy - ortho - benzoyl - benzoic acid.

Abstract Published.

283,868.—Containers for acids, etc.—Traun, H. O. (trading as Traun and Sohne vorm. Harburger Gummikann-Compagnie, H.), 59, Meyerstrasse, Hamburg, Germany.

Hollow-ware non-metallic; compositions containing synthetic resins.—Bottles or other containers for hydrofluoric acid and lie corrosive substances are made from or covered with artificial resin, such as a phenol-formaldehyde condensation product, preferably mixed with finely divided graphite, and given a protectice coating of varnish or other material. The necks of the containers are provided with an external layer of hard indiarubber in which a durable screw thread can be formed. The containers have enlarged, flanged bases.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

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486,953.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—Schering-Kahlbaum Aktiengesellschaft, 170-171, Mullerstrasse, Berlin, N.39, Germany. March 14th.

SELECTAN.

486,502.—Chemical substances prepared for use in medicine and pharmacy. —Schering-Kahlbaum Atiengesellschaft, 170 & 171, Mullerstrasse, Berlin, N.39, Germany. March 14th.

TRIDYNOL.

487,635.—Chemical substances prepared for use in medicine and pharmacy.—Paul Auguste Louis Delmasure, Rue de L'Orpheon 2, Lille, France. March 14th.

485,311.—Illustration of a crescent and the word SOLVAY for alkalies, in class 2, for agricultural, horticultural and export to or sale in China, Hong Kong, Mongolia, Thibet, Siberia, all Chinese Territory leased to foreign powers, French Indo-China and Hainau.—Brunner, Mond & Co., Ltd., Winnington, Northwich, Cheshire. March 14th.

OKURIN.

486,755.—Chemical substances prepared for for use in medicine and pharmacy.—Edward James Loosmore, 10, Gleneagle Road, London, S.W.16. February 29th.

HEPATOPSON.

487,680.—All goods in class 3 which includes chemical substances prepared for use in medicine and pharmacy.—Chemische Fabrik Promonta Gesellschaft mit beschränkter Haftung, Germany. February 29th.

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CONTENTS. PAGE.

An Atomic Model for the Chemist VIII. 209
By Florence Langworthy.

Activated Carbon: Some Industrial Applications 212
By J. T. Strachan, A.I.C., F.C.I.C.

General Notes:—

Scientific Study and the Human Factor 215

National Conference on Smoke Abatement 215

Ramsay Memorial Laboratory of of Chemical Engineering 215

Canadian Chemical Industries — Their Growth and Future Prospects 217

Development Problems in the Exploitation of Natural Gas 219
By Lieut.-Col. S. J. M. Auld, O.B.E.

Proceedings & Notices of Societies:—

The Royal Society 220

The Optical Society 221

Notices of Books 222

New Patents 223

New Trade Marks 224

AN ATOMIC MODEL FOR THE CHEMIST, VIII.

By FLORENCE LANGWORTHY.

The yellow helium atom will be neutral because it will consist of four negative electrons and four positive electrons. The green helium atom has four negative electrons to three positive electrons, but the double-positive is, in a way, balanced by the two outer electrons and so we can understand its being neutral in so far that it will not combine with other atoms. We can, however, also understand that it will not prove neutral to any particle that succeeds in coming between its double-positive nucleus and its distant electrons. Let us picture a negative particle—attracted by the double-positive—as thus getting between the nucleus and its electrons. Owing to its positive body it is thus able to make a closer approach than the electrons. If the latter were not there, then the negative particle could remain at a discreet distance, though, even so, its electrons would be attracted away from it by the double-positive while its positive body would be repelled to a distance as we saw in the case of the atom of yellow helium. But since the outer electrons are in place, the attracted negative particle is in a dangerous position. It has managed to get through the comparatively wide orbit of the circling electrons because it is not a pure negative like them, but has a positive body wherewith to modify the repulsion of the inner electrons of the nucleus. Its very presence, however, has now aroused the repulsion of the outer electrons more than ever and so this tiny comet finds itself repelled by the circling electrons upon this double-positive sun. This would not matter if the double-positive were pure, but it contains hidden negative electrons and these, though they have suffered it to come thus near on account of its positive body wil lnot suffer it to come too near with impunity. There is thus a double action of attraction and repulsion such as we see with our own sun and comets, and finally this little comet is driven too near the atomic sun by the outer repulsion with the result that its electrons are shot away from it. Since they are pure negatives they cannot be repelled past tbe circling outer electrons and therefore they take up their orbits within the same—going to the making of the corona as the first pair of coronal electrons. Their positive, needless to say, has not been repelled by the inner negative electrons, but now that it has been deprived of its electrons it certainly cannot be tolerated there by the double-positive. It is violently repelled by the same. Not until it has reached a distance far beyond that of the outer electrons (the electron-planets) are its coronal electrons able to bring into play their pull on it. Then it is pulled into position and starts on its orbit as the first of the major planets. The weight of the atom—now that it contains another positive electron separated from its two negative electrons—has gone up from 4 to 6. It is no longer a helium atom but a lithium atom (the atomic weights of the isotopes of lithium are 6 and 7). And as the new planet is a pure and ionised positive it speedily attracts a negative particle, but as the electrons of the same are not separated from their positive this does not add to the atomic weight.

We are justified in assuming that the double-positive acts in the manner above described seeing that it has been noticed that the double-positive in its flight has a curious effect upon the electrons in the surrounding matter. An electron will fly out, as it were, in response to the attraction of the double-positive, and then, instead of following it, fall back. This certainly looks as if it had gone too close and experienced repulsion from the inner negative electrons that are holding the double-positive nucleus together. We should expect clouds of negative electrons to be following the ionised double-positive; instead they fall back as if the had been attracted too far and had received repulsion. This behaviour, too, would explain why it is that matter remains, more or less, separate instead of being welded together in one great mass, as it should be under the influence of gravitation. There is this repulsion to counter-balance the latter force. Our double-positive and our proton witb their mixture of positives and negatives that suffers neither negative nor positive to come too near with impunity, seems to be the key to the problem of this division of matter. It has been said that each of us has his or her own centre to which others must not come too near, and this *noli me tangere* attitude seems to be innate in the very atoms.

In the lithium atom, described above, then, we shall have a double- positive sun with two distant electron-planets. Held up by the latter will be two coronal electrons belonging to the remote lithium planet, the which, in its turn, holds up a negative particle. When the double-positive sun-atom catches another negative particle, its electrons will be forced to take up an orbit still nearer to the sun-atom since they will be held up by the coronal electrons of the lithium planet as well as by the electron-planets. Their positive will also take up an orbit within that of the lithium planet. The atom will now be beryllium instead of lithium and its atomic weight will be 8 instead of 6. Its frequency will be higher since its coronal electrons have thus been forced to perform a smaller orbit. These coronal electrons will be held up more securely than those of the lithium planet, for while those of the latter were kept in position by the repulsion of the electron-planets and of the negative particle attached to the lithium planet, there are now not only the electron-planets and the negative particle attached to the lithium planet but also the coronal electrons of the lithium planet and the negative particle attached to its own (beryllium) planet to keep them in position. If we picture the lithium planet as being a planet that revolves beyond Neptune, then the beryllium planet will be the atomic Neptune with its orbit within that of the lithium planet. The next particle will go to the formation of the boron planet (Uranus) with the atomic weight of 10 and a still higher frequency than that of its companions. And higher and higher still will be the frequencies of the succeeding planets as well as their atomic weights :—the carbon planet (Saturn) 12; the nitrogen planet (Jupiter) 14; the oxygen planet (the missing planet whose place is taken by the asteroids) 16. Here de shall have six major planets. The last of them, the oxygen planet, is somewhat near the sun-atom and so the next positive that is thrown out falls *within the orbit of the electron-planets.* These attach themselves to the excited positive with the result that a new kind of planet is formed, the first of the minor planets, fluorine (Mars) 18. But the very formation of this planet puts an end to the sun-atom's activity since the electron-planets are no longer purely negative and so cannot repel a captured particle upon the sun-atom—in other words, the latter has been turned from an atom of green helium into an atom of the yellow inactive helium. The captured particle, therefore, remains where it is and as it is a negative and as the atom has gradually grown more and more negative with the addition of each negative particle attracted by each planet, a positive electron is attracted to the negative particle. The excitement of the same on joining up with the negative, draws a rush of negative particles to itself in consequence of which the electrons of one of them—repelled too near—are shot off by the concealed negative and a new sun-atom is formed. There will thus be two sun-atoms to form two poles to the sun-region; one is the sun-atom (inactive)—of a complete negative system, while the other sun-atom (active) is ready to build up a new system. The atom's centre has been split into two and so its orbits will now pass from the circle to the ellipse.

The next planet is thrown off by the new sun-atom to the distance of the lithium planet to which it is apparently attracted by the negative of the same only to be repelled by the positive planet. The result of this attraction and repulsion is to make it a satellite of the planet. In its turn it attracts a negative particle and so is repelled still further out from its primary. But

though this planet—the sodium planet—is thus with the lithium planet at a considerable—comparatively—distance from the sun-region, its coronal electrons are nearer to the atomic sun than any of the others *for they cannot be repelled past them. And* so the sodium planet has the highest frequency of any of the planets that have—so far—been made.

In this way, then, we can picture the building up of the planets. Unlike the Bohr atom, this atomic system is like the solar system. It has planets that are planets and not merely negative electrons. We cannot imagine our planets as being composed of negatives only. If the microcosm is like the macrocosm then the planets must contain positives as well as negatives. By building up the atom in this way, we enormously simplify the problems we have to face. Our sodium planet, for instance, will be positive in virtue of its position—because it is the first planet of its system. But the negative particle that attaches itself to this positive somewhat modifies this positivism so that sodium atoms that have not lost their negative particle will be more negative than those that have. Then again if this negative holds up another positive electron, there will be two positives in the combination, and the sodium atom will be ultra-positive. In such a case we shall expect it to yield a red light whereas when it has its negative particle to the front we shall expect it to yield a green light. And if we see a fairly equal number of both kinds of atoms we shall expect sodium to yield its yellow light. The sodium atom with two positives is apparently a damaged atom. Let us picture a negative particle endowed with the frequency of our sodium atom as being shot into it. The inner electrons of the sun-atom repel the electrons into the nearer of the two orbits of the coronal electrons of the sodium planet, and they repel the electron therefrom, while the repulsion of the sun-atom carries the positive to the sodium planet. Attracted by the negative of the same, it performs its orbit. The atom has lost one coronal electron and gained two. Its weight therefore has increased by 1. But as there are now two positives pulling upon three coronal electrons instead of one upon two, the atom is not so stable as it was. It is significant that it is from the elements of uneven atomic weight that Sir Ernest Rutherford is most successful in knocking out protons—that is to say, he is more successful with such an element as beryllium (9) than with such an element as oxygen (16). With this atomic model we can understand why the inverse square law obtains. We can also understand the problem of valency. When, for instance, the atom is fluorine it can hold up one atom of hydrogen, but when the fluorine planet departs the system has lost one positive planet and so the sun-atom will tolerate two positive hydrogen atoms being held up by the oxygen atom. When the oxygen planet goes on its way, the system has lost still another positive and so the nitrogen atom can hold up three positives. The departure of the nitrogen planet entails the loss of still another positive and so the carbon atom can hold up four positive atoms. But when the carbon planet goes the system cannot hold up five positives, although it has lost another positive, because there are not enough planets with their negative hooks left. The boron atom will only be able to hold up three instead of five; the beryllium atom will have to content itself with two instead of six, while the lithium atom will be reduced to one. When it comes to holding up negative atoms, however, the sun-atom will, as a double-positive, show no repulsion. Negative atoms will be able to oust the weaker negative hooks, so that the sulphur atom—negative though it is—will be able to hold up with its six major planets six atoms of fluorine. The elements, too, on either side of carbon will differ also in respect to their valency activitly. Lithium, beryllium and boron can only be positive or very slightly negative since there are three negative particles at most (in boron) in the system with them. But when we come to nitrogen the system contains five negative particles so it can be a pronounced negative, or when it is damaged and gains another positive it can be positive. Oxygen will be even more negative with six negative particles in its system, while it can also, when damaged, have two positives to its planet. Sir Joseph Thomson has come across many of these "double-positives" in his experiments. And though fluorine—since it is a minor planet—can never be this sort of double-positive, yet it can have its intense negativism modified when damaged by having another positive to its planet so that this will consist of two positive electrons and two negative electrons. It is best, however, to reserve the descriptive term "double-positive" for the atoms wherein two positives are in juxtaposition rather than use it in this case of the major planets where there would be a negative particle separating the two positives.

When the damaged major planet escapes from the atom, therefore, it will do so as an X-ray—provided it is a single planet—and it will have the atomic weight of 8 unless its electrons have been shot away from it. On passing out of the ray state it will become a hydrogen atom. Thus the frequency of hydrogen atoms will be extremely variable. One that has escaped from a damaged lithium atom (7) leaving behind it only an atom of helium (4) will have its electrons at so far a distance—comparatively—that it will speedily lose the two outer ones and so appear as Hydrogen A. But from a damaged sodium atom — the electrons of which will be much nearer the nucleus since their frequency in the atom was higher—the they will not be lost so easily. In this way, then, with a higher and higher frequency, every element from lithium to uranium will yield its own kind of hydrogen atom. We have no need to picture electrons as jumping about from one orbit to another—as in the Bohr atom—to account for the Balmer lines of the hydrogen spectrum. The Bohr atom does not explain why the electrons are confined to certain orbits. This atom does explain it, for these diverse frequencies will have been impressed upon the electrons in the birthplace of every hydrogen atom— the mother atom.

Our atom, then, will not be built up of hydrogen atoms but it will lose one when ever its chief major planet—already damaged—is lost to it. By " chief " planet is meant the carbon planet in the carbon atom, the oxygen planet in the oxygen atom, and so on.

This atomic model is a simple one and therefore—as Newton would say—the more likely to be true. Anything that is fundamental is sure to be simple. Let us not, then, look upon the light from the hydrogen atom as being due to the jump of an electron from one orbit to another. Let us say instead, with Newton, that light is corpuscular, that it is matter in a certain condition, and that when we see hydrogen atoms, red, green and blue, it is because some of these ionised atoms have entered our visual organs. To object that the hydrogen we see in the sun cannot possibly have travelled to us is surely out-of-date in these days we are told that space—instead of being empty—is crowded with atoms. We are also told that " oxygen appears to be monatomic in the auroral levels, 60 miles and more above the earth." And since " purely or mainly monatomic matter can exist only at temperatures so high that the combinatory forces cease to operate—*e.g.*, in the sun and fixed stars," then we may well look upon that oxygen as having been thrown off by the sun and as having travelled to us with the speed of light. As newly-ionised atoms there will be a rush on the part of the earthly oxygen molecules to join up with them and so we shall get ozone in the upper atmosphere as well.

We can picture the excited sun-atom in the heated carbon atom on earth as attracting away the negative particle from the negative oxygen atom and then repelling the positive as a ray of light with a negative in pursuit of it. But what a slight repulsion would that be compared to that which a positive would experience from a sun full of excited sun-atoms !

ACTIVATED CARBON : SOME INDUSTRIAL APPLICATIONS.

(*Summary of paper read by* J. T. STRACHAN, A.I.C., F.C.I.C., *at Huddersffield, before the Society of Dyers and Colorists and the Huddersfield Institute of Chemistry, March* 27, 1928.)

INTRODUCTION.

The chief technical applications of Activated Carbon are :—

(1) (In powdered form) for decolorising sugar, chemical products, edible oils and fats, and

(2) (In granular form), for use in gas masks so as to purify the air from toxic gases; also used for recovery of solvent vapours from air of factories utilising solvents in industrial processes.

The decolorising qualities of Vegetable Carbon were known as long ago as the 15th century, but the phenomenon received scant attention until the matter was revived by Löwitz in 1785. Figuer's discovery of bone char in 1812 and the concentrated and successful efforts of researchers to develop the latter product resulted in the comparative eclipse of the vegetable product for a considerable period. The revival of interest in the latter is due to Debussy, who formulated improved methods of production. This work as been carried on and particularly during the past twenty years, vegeta-

ble char has received very great attention on the part of chemists. At the present time there are numerous Carbons on the market bearing distinctive trade designations.

PRODUCTION.

Activated Carbon is produced by the destructive distillation of different vegetable materials (such as wood, peat, lignite coal, rice hulls, nut shells, etc., etc.), under special conditions of chemical treatment and heating.

The chief methods may be conveniently grouped as follows, *viz.* :—

(1) (a) By selection of the material which is afterwards heated.—(Type : blood carbon).
(b) By the deposition of Carbon on a porous base of inorganic materials.—(Type : bone char).

(2) By addition of chemicals such as Phosphoric Acid, Chlorides of Zinc, Iron, Calcium, etc., after which the mixture is heated to 400°-800° C.—(Type : Carboraffin).

(3) By carbonisation of an organic material after which an activation at high temperature (600°-1,000° C.) by gases such as steam, Carbonic Acid, Carbon Monoxide, Chlorine, etc. — (Type : Norit).

These various methods were more fully elaborated by some brief remarks on theoretical aspects and general principles of testing.

GRANULAR CARBONS.

These Granular Carbons found considerable application during the recent Great War in gas masks for the adsorption of poisonous gases from the air. According to Prof. Bancroft the adsorbent had to be capable of reducing the concentration of the toxic gases from about 1,000 parts per million (by volume) to 1 part per million within the 1/10th second that the air takes in passing through the canister. This can be accomplished with a safe margin by several of the carbons at present available.

Granular carbons have now a wider application in certain industries for the recovery of solvent vapours from the air of factories. Large quantities of valuable solvents are being used to-day in manufacturing plants such as Artificial Silk, Cordite, Celluloid, Dry Cleaning and Rubber factories. Rapid evaporation of the solvent is a prime necessity for economical operation, but unfortunately, most of this vapour goes to waste. Already industrialists are taking a keen interest in the commercial possibilities of granular Vegetable Carbons as a means of adsorbing and recovering these vapours, and a number of the more important concerns have erected installations for this purpose in this country, in Europe, and in America. The owners of some of the large oil wells in Europe and America have erected carbon adsorption plants for the recovery of gasoline from natural gas with distinct financial advantage to themselves. The cooled air-vapour mixture is passed through a layer of Carbon in a cylindrical insulated vessel at a specific speed and the vapour is selectively attracted by the enormous outer and inner surfaces of the porous carbon granules. The air leaves the adsorber practically stripped of its vapour contents. The vapour is recovered from the carbon by application of steam and subsequent condensation. The carbon is dried with hot air and finally cooled, when it is again ready for the adsortion process. Amongst the essentials for a vapour adsorption carbon are high power of adsorption, hardness and firmness of structure, regularity of size and shape of granules and low retentivity. The new moulded type of granules produced by the manufacturers of Norit Activated Carbons meets these requirements and these grades have proved of immense practical value to those concerns interested in this subject, owing to their great activity and hardness and low resistance to passage of air and gases as compared with natural shaped granules offered by other firms. Various technical aspects of the adsorption process were elaborated upon and the essential factors for prevention of high losses during operation were discussed.

POWDERED CARBONS FOR DECOLORISING.

(a) *Edible Fats and Oils.*

Fuller's Earth has been used for many years for the bleaching of edible fats and oils. When Vegetable Carbon was first introduced to this industry, it was thought that it would not be possible to compete against the much cheaper Earth. Further investigation proved that the two products were really allies and their actions on oils were complementary. When the Earth and Carbon were added to the neutralised oil or fat in certain definite proportions (depending on the oil being retreated) much smaller percentages of the mixture can produce equal or better results than if Earth were alone used.

The saving involved is not only in cost of bleaching material but also in reduced losses by retention of oil in the smaller filter cakes. In addition less material has to be handled, less filter press capacity is required, smaller expenditures on filter cloths and less labour are necessary. The composition of Earth-Carbon mixtures necessary to effect maximum decolorisation varies somewhat according to the oil being treated. For solid oils (Coconut and Palm Kernel) the best results are usually obtained with a mixture containing 20—25 per cent. Carbon, whilst on liquid oils (Cotton Seed, Ground Nut, etc.) 10—15 per cent. of Carbon is frequently found to be sufficient. Various instances and cost figures were cited and shown graphically by means of curves.

(b) *Chemicals.*

For the treatment of many chemical products a pure neutral carbon free from iron salts, chlorides, sulphates, lime, etc., is frequently necessary—particularly in the refining of pharmaceutical glycerine, photographic salts, fine organic acids and salts, alkaloids, etc. The removal of such impurities from carbon is a most difficult matter requiring enormous quantities of washing chemicals and water for complete elimination. A description was given of the Norit Filter which is often convenient for treating volatile liquid which cannot well be handled in an ordinary filter press. This filter can be convenient for decolorising relatively small quantities of solutions—one unit taking 20-80 gallons per hour. Some remarks were made on the purification of water with carbon.

(c) *Sugar.*

The largest application for vegetable carbon is undoubtedly in the sugar industry.

Three types of factories were reviewed, *viz.*—

(*a*) Factories where raw sugar is made from cane or beet.

(*b*) Refineries where raw sugar is refined into high quality white sugar for consumption.

(*c*) Factories, also working cane or beet, but manufacturing a white sugar for consumption which usually is not of such high grade as refinery sugar.

Bone Char has been largely used for many years in the refining and decolorising of sugar. The peculiar features of the bone char process are, high initial cost, high operating costs, demand for large quantities of pure water and skilled labour required. Sugar manufacturers are now paying special attention to the advantages offered by the use of Vegetable Char (either whole or partial in conjunction with their bone char equipment). The plant is cheaper to erect; the process is easier to handle; large volumes of water are not required; small amounts of sugar or liquor are present between initial and final stages of the refinery; less prolonged heating—smaller losses.

The process is specially attractive to factories producing sugar direct from beet or cane, as it can be added readily to the existing plant and enables the manufacturer to turn out a white sugar which can compete with the product of the refineries. Small plants can be operated advantageously. The various technical advantages of vegetable char over bone char were outlined and the technique of present-day practice indicated. The high mportance of carbon being a first-class filterng medium as well as a good decoloriser was emphasised and curves showing the comparative filtering and decolorising capacities of various well-known carbons were demonstrated.

Norit carbon, owing to its method of manufacture retains its needle-like structure and is generally recognised by refiners as the best filtering carbon aavilable.

Revivification of Spent Sugar Char.

Finally reference was made to the revivification of spent char.

(1) Burning in absence of air in a Norit kiln which was described.

(2) Washing with acid periodically to eliminate adsorbed ash.

(3) Washing with alkali solution. This can be applied instead of the burning process but it is not so efficient. Simple apparatus is its chief advantage.

Provided the kiln is not overloaded, the carbon can recover 90 per cent. of its original decolorising power and subsequent regeneration does not materially affect this figure. The losses may amount to 3 per cent. of the tonnage of Norit treated daily so that the total loss of Carbon based on treated sugar is negligible. Practical experience shows that a revivification plant pays for itself in a very short time. The new Supra Norit Sugar grades were incidentally referred to. These are 2 to 5 times more active than the normal standard grades. These Supra grades are so active that, by their use, revivification may be economically omitted if desired.

GENERAL NOTES.

SCIENTIFIC STUDY OF THE HUMAN FACTOR.

The National Institute of Industrial Psychology, of which the Earl of Balfour is President, has been carrying out much interesting work during the past year into the value to industry of the scientific study of the human factor, and the serious consequences of neglect. There has been a growing demand for the application of the Institute's methods in the general organisation and lay-out of factories.

CHEMICAL WORKS.

The assistance of one of the Institute's investigators has been requested during the erection of one of the largest plants in the country. The recommendations so far made and adopted include the establishment of a planning department. Its function is to forecast and to record the progress made in all sections of the constructional work. By the programmes and forecasts thus obtained, the activities of the drawing office, purchase department, and construction department will be fitted to a common scheme. The progress records are being used to reveal likely difficulties, and as a basis for framing more accurate programmes of future work. Changes have been introduced so as to eliminate wasted time in the transport and delivery of construction materials. The investigator has also surveyed the chemical processes of the plant with a view to installing selection tests for workers; he has likewise systematised the study of accident and sickness incidence. The services of a second investigator have since been requested; he has begun work on certain problems relating to stores organisation.

MUNICIPAL OFFENSIVE URGED BY NATIONAL CONFERENCE ON SMOKE ABATEMENT.

£120,000,000 A YEAR ECONOMY PROPHESIED.

The suggestion that local authorities should take into their own hands consideration of the problem of domestic smoke was made by Dr. S. G. Moore, Medical Officer of Health for Huddersfield, at the national conference held in the Manchester Town Hall on Thursday (March 8) under the auspices of the Smoke Abatement League of Great Britain. Two hundred and twenty-five delegates from local authorities were welcomed by the Lord Mayor.

Dr. Moore suggested three courses of action as practical measures against the offending household chimney :—

1. Careful examination of the principle of "Less smoke, smaller rates"—as contained in the suggestion of Sir Napier Shaw, the Chairman, that there should be a rebate of 3d. in the £ off the sanitary rate to persons who used gas or electrical appliances or burned smokeless fuel.

2. Encouragement of the building of houses so equipped that the burning of raw coal would be reduced to a minimum.

3. Inquiry into our smokeless fuel resources with the intention that the vast bulk of the population of great industrial towns, who had no choice in their heating and cooking equipment, should be taught the advantages of using solid, smokeless fuel.

Dr. A. Des Vœux, of the London Coal Smoke Abatement Society, declared that the smoke abatement movement was going to save the coal industry, and prophesied that in a few years the 60,000,000 tons of coal dust wasted annually in the mines would be utilised by low temperature carbonisation and made as valuable as coal now sold at £2 a ton.

RAMSAY MEMORIAL LABORATORY OF CHEMICAL ENGINEERING.

£23,555 ALREADY SUBSCRIBED.

The chemical Engineering Building and Equipment Fund Committee of which the Rt. Hon. Sir Alfred Mond, Bt., is Chairman, Sir Robert Waley Cohen, Vice-Chairman, and Sir David Milne-Watson, Hon. Treasurer, recently issued an appeal for a capital sum of £50,000 for the extension of the Ramsay Laboratory of Chemical Engineering at University College, London, and for its equipment. The response up to the present time has produced £23,555. Among the subscribers are :—

Imperial Chemical Industries, £10,000; The Shell Group, £5,000; The Gas Light and Coke Company, £5,000; Dunlop Rubber Company, £1,000; Reckitt and Sons, Ltd., £1,000; British Aluminium Company, £250; British American Tobacco, Ltd., £250; South Metropolitan Gas Company, £105; Col. Sir Edward Brotherton, £100; Mather & Platt, Ltd., £100; "Wellwisher" £100; The Worshipful Company of Salters, £52 10s.; Professor E. C. Williams, £50. Other subscriptions, £548 2s. 11d.

In addition to the capital fund for the building and equipment, an income of £6,000 a year is required for the maintenance of the Laboratory. Towards this £3,191 have already been promised for the first five years and £2,600 for the second five years.

The Committee is anxious to complete both funds as speedily as possible in order that the new buildings may be proceeded with. Donations and subscriptions may be sent to Sir David Milne-Watson, at University College, London (Gower Street, W.C.1.), who will be glad to supply any further particulars.

CINEMATOGRAPH FILMS ACT.

Board of Trade Notice to Renters and Exhibitors.

The Board of Trade wish to remind renters that on April 1, the requirements of the Cinematograph Films Act in regard to licensing, to quota of British films, and to the keeping of a record book come into force. Before that date every film renter must apply for a licence to carry on business, and forms of application may be obtained from the Industries and Manufactures Department, Board of Trade, Great George Street, London, S.W.1.

The attention of exhibitors is called to the fact that from April 1 no film to which the Act applies may be exhibited to the public unless it has been registered. This requirement, however, does not apply to films which were exhibited in Great Britain before the end of 1927; nor does it apply to a pre-release at one theatre only when application has been made for registration.

SHEFFIELD MEDICAL OFFICER AND THE SMOKE NIUSANCE.

(*To the Editor of the* Chemical News.)

Sir,—The decision of the National Smoke Abatement Conference recently held at Manchester to recommend local authorities to make use of existing powers for the mitigation of domestic smoke and to encourage, by educational and other means, the use of smokeless fires is a forward step in the purer air movement. It focuses attention on the immediate possibilities of the serious attempts now being made to tackle this important aspect of the question.

The resolution contained a recommendation to local authorities that they should inquire into the progress of low temperature carbonisation with the object of discovering the available supplies of smokeless fuel. The progress made in Yorkshire in the scientific method of treating coal is evidence that we can no longer adopt the conservative official view that low temperature carbonisation has not yet reached the commercial stage; and municipal authorities might, by example and education, gradually teach people that it is possible for them to help in smoke abatement without interfering with the open fire. My own experience as a user of low temperature carbonisation fuel has been that it lights as easily as ordinary coal, gives a bright and cheerful fire, emits more heat than the equivalent volume of coal, and, bulk for bulk, makes less ash.

From the information placed before the Conference, it seems fairly clear that once the demand for smokeless fuel sets in there will be no difficulty in erecting self-contained plants at the pit-heads or in the centres of population, where the transport charges will be relatively low, and the gas and other by-products will be alongside a ready market. It is only by active encouragement of the demand that we can hope to stimulate the successful exploitation of the low temperature system of treating coal.

From the purely economic viewpoint, it would pay local anthorities actively to encourage domestic smoke abatement, which would reduce the cost of removing refuse, and also of preserving and renovating public buildings, which suffer serious damage from smoke. The smoke problem of great cities is now so serious that local authorities might, I think, consider the question of jointly urging the Government to give them powers enabling them to schedule highly congested districts as areas in which it should be an offence against by-laws to burn raw coal.

I am, Sir, etc.,

(Sgd.) Fred E. Wynne,
Medical Officer of Health,

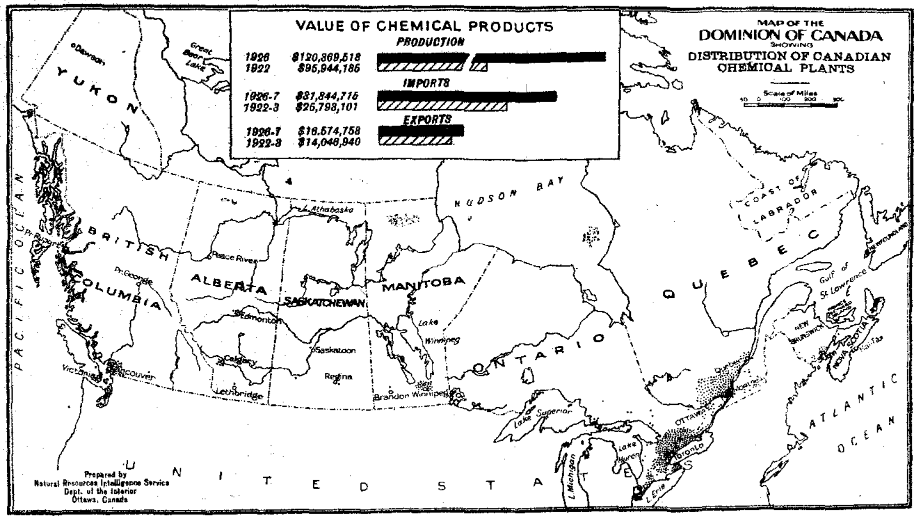
Sheffield.
March 20, 1928.

CANADIAN CHEMICAL INDUSTRIES. — THEIR GROWTH AND FUTURE PROSPECTS.

The remarkable development of the industries of Canada has more than kept pace with the growth of population. Chemistry, which is of great importance in most industries, and plays a predominant part in the development of others, is being fostered by the Dominion Government, who recognise its importance to the whole community. The progress of the Chemical and kindred industries was strikingly shewn in a recent issue of *Canada* (the illustrated weekly of London and Toronto, which takes a prominent part in making known the vast resources and always growing importance of Canada). We are indebted to our contemporary for the facts and figures, and also the illustration accompanying these notes.

(*Continued on Page* 218.)

CANADIAN CHEMICAL INDUSTRIES—THEIR GROWTH AND PROSPECTS.



In the records of the Dominion Government at Ottawa the Canadian chemical industry proper comprises 10 groups of industries, *viz.*: acids, alkalies, salts, and compressed gases; paints, pigments, and varnishes; soaps, washing compounds and toilet preparations; medicinal and pharmaceutical preparations; explosives, ammunition, fireworks, and matches; coal tar and its products; inks, dyes, and colours; wood distillates and extracts; fertilisers; and a group of miscellaneous products, such as adhesives, celluloid products, and insecticides.

The Chemical Industry Proper.

This industry, like most Canadian industries, is making substantial progress. In 1926 the production of chemicals and allied products from 533 plants had a value of $120,369,518, which was 7.5 million dollars better than it was in 1925 and the greatest recorded since 1920, when much higher prices prevailed. Except for the year 1921 the volume of production has grown steadily since 1919,and the 1927 figures will likely show a further increase, both in volume and in price, over the coresponding figures for 1926. The number of employees was 14,000, and the capital invested in the 10 groups was $132,279,179.

Heavy Chemical Plants.

Of these 10 groups the most important is that relating to acids, alkalies, salts, and compressed gases. The 1926 production from this group had a value of $28,717,401, which was higher than it was in the war year of 1917, despite the greater number of plants at that time. The output of sulphuric acid (60° Bé.), which is a fairly reliable index of conditions chemical, was about 210,000,000lb., exceeding the 1925 figures by 48,000,000lb. This gratifying increase was largely the result of the erection of the Mond Nickel Company of a contract sulphuric acid plant in 1925, the capacity of which was doubled late in 1926, to use the Bessemer sulphur gases which were formerly burnt to waste at the nickel works at Coniston, Ontario.

Electro-Chemicals.

In the manufacture of electro-chemical products, such as calcium carbide, cyanide, caustic soda, bleaching powder, liquid chlorine, and phosphorus, progress has been most marked, thanks to the many opportunities for the development of electrical enerby in large volume at low cost.

Importance of Water-Power.

Water-power has, in fact, made Canada the important manufacturing country that she is—has made Niagara Falls, in Ontario, and Shawinigin Falls, in Quebec, busy centres of thriving electro-chemical and electro-metallurgical plants; and recently has attracted additional industries of great magnitude to the Lake St. John and Gatineau districts of Quebec. The development of the industries connected with plants and varnishes, soaps, washing compoments, various toilet preparations, coal tar and its numerous products, wood distillation, fertilisers, etc., etc., has been commensuiate with their importance.

Imports and Exports.

To Canada's external trade the chemical industry proper contributed $48,419,468 in the 1926-27 fiscal year. Imports had a value of $31,844,715 and exports of $16,574,753; these figures compare with $24,760,237 and $16,209,820, respectively, in 1925. Fertilisers accounted for $3,492,448 of the imports in 1927; paints and varnishes, $4,607,411; drugs, medicinal and pharmaceutical products, $3,108,199; celluliod products, $2,335,358; soap, $1,204,622; perfumery, cosmetics, and toilet preparations, $1,103,653.

Among the exports, fertilisers had a value of $4,613,059, in which cyanide was represented by $3,821,501; calcium carbide, a value of $1,507,968; sulphuric acid, $267,888; soda ash and sodium compounds, $3,601,048; ammonium sulphate, $766,688; and paints and varnishes, $499,691.

"Canada" Concludes Its Review.

A careful examination of the production and trade returns will indicate the probable lines along which Canada's chemical industry will expand. There is as yet no production either of synthetic ammonia or of synthetic nitrates, despite the growing developments of other countries; nor is methanol being synthesised from coal-gas. Nevertheless, Canada's great supplies of raw material and her adequate supplies of water-powers ensure a growing and prosperous chemical industry, and the time is approaching when great chemical enterprises will be utilising to the full the resources of bituminous sands, oil shales, ilmenite ores, the natural deposits of sodium sulphate, and the

DEVELOPMENT PROBLEMS IN THE EXPLOITATION OF NATURAL GAS.

By LIEUT.-COL. S. J. M. AULD, O.B.E., M.C., D.Sc., F.I.C., M.Inst.P.T.

(*Before the Institution of Petroleum Technologists, March 13.*)

The utilisation of the gas produced at an oilfield, either simultaneously with the oil at the well-head or by evolution on subsequent reduction of pressure, is a matter of much importance and a great deal of attention has been paid to the subject in recent years. In tropical countries utilisation is not the straightforward matter it may be in temperate climates and in recent years exploitation has been further complicated in a number of fields by the presence in the gas of large quantities of hydrogen sulphide. In some parts of Texas, Mexico and Persia this amounts to over ten per cent. by volume.

SEPARATION OF GAS AND OIL.

For a variety of reasons it is desirable to be able to separate gas from oil in stages, *i.e.*, at chosen pressures, prior to the final separation at or near atmospheric pressure in flow or storage tanks. Owing to the advantages accruing from increased velocity caused by gas evolution it is not always expedient to remove gas as it separates in pipes; but it is essential for general control, and in some cases for economic fractionation of the gas, to have high pressure separators installed at suitable points on the main oil-collecting lines throughout an oil-field. Most proprietary types of gas separator appear to have been designed for comparatively low Gas/Oil ratios.

MEASUREMENT OF QUANTITY OF GAS.

Measurement of the volume of gas is frequently carried out by observation of pressure drop in flowing lines. This is a matter of fundamental importance to all interested in the transportation of gas. No apology is needed therefore in discussing the flow of gas in pipes, and for the introduction of the question of the general inapplicability of exponential pressure-drop gas-flow formulæ and the use of the Stanton Curve.

Formulæ relating pressure drop to gas flow are very numerous. They are practically all of the same type, but fall into separate categories for high and low drops respectively. Those which have immediately concerned the writer, and are therefore under special consideration, are the following well-known equations:

High Pressure.

Weymouth ... $Q = K\sqrt{\frac{(p_1^2 - p_2^2).d^5}{g.T.L.}}$

$$K = 18.06\,\frac{T_0}{p_0\sqrt{G.T.}}$$

Oliphant ... $Q = 42\,a\sqrt{\frac{0.6\,(p^{12} - p_2^2)}{g.L.}}$

The coefficient " a " is a function of the diameter.

Low Pressure.

Weymouth ... $Q = 2141\sqrt{\frac{d^5 . P}{g.L.}}$

Molesworth ... $Q = 1732\sqrt{\frac{d^5 P}{g.L.}}$

Pole ... ... $Q = 2338\sqrt{\frac{d^5 P}{g.L.}}$

The high pressure formulæ of Weymouth and Oliphant are amongst the last of the empirical formulæ. They take into account the possible variation of the coefficient of friction but regard it as wholly dependent upon d. From a study of existing data Weymouth considered it to have the value $\frac{0.008}{d^{\frac{1}{3}}}$, hence the value of the exponent in his formula. Oliphant used ζ as a function of $d^{\frac{5}{2}} + \frac{d^3}{30}$. In the low pressure formulæ change in velocity and density along the pipe neglected, and the simplification of the Weymouth formula is attained by regarding $p_1 + p_2 = 2p_0$ for gas measured at or near atmospheric pressure. It is to be noted that the coefficient of friction used is identical with that employed in the derivation of the high pressure formula. The same mode of thought can be traced in the derivation of the other equations quoted, and it is scarcely a matter for surprise that these empirical formulæ do not merely not agree amongst themselves, but do not and cannot apply for any but the particular conditions under which the coefficient of friction was measured.

Reynolds in 1883 showed that the critical velocity of a fluid is a function of its density and viscosity and of the diameter of the ppe, and that $\frac{WVd}{\;}$ or, as it may be alter-

natively written, $\frac{Vd}{\nu}$, is a constant. This constant is the Reynolds Criterion; and though it has two values depending on whether the fluid has suffered initial disturbance or not, the latter or lower value is if the greater practical importance. Rayleigh's generalisation of Reynold's Law showed that

$$R = WV^2F$$

By plotting $\frac{R}{WV^2}$ against $\left(\frac{Vd}{\nu}\right)$ Stanton gave expression to the fact that for any possible combination of velocity, pipe diameter and kinematic viscosity there is a definite value of $\frac{R}{WV^2}$ and hence of the coefficient of friction ζ, which is $\frac{R}{\frac{1}{2}WV^2}$ and is thereby evaluated. It is only necessary, then, to determine experimentally for particular pipe or, in special cases, for particular pipe in use with a particular fluid which may affect its properties, the relationship between $\frac{Vd}{\nu}$ and $\frac{R}{WV^2}$ in order accurately to predict the coefficient of friction in pipe of similar roughness for any fluid of known density and viscosity.

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.

The following papers were read at the meeting held on Thursday, March 1:—

The Structure of the Band Spectrum of Helium. By W. E. Curtis. Communicated by T. H. Havelock, F.R.S.

Details are given of three new helium bands which have the final electronic level 2P in common. Two of them are due to the vibrational transition 1⟶1, the initial electronic levels being 3S and 4S. The other has an initial electronic level of effective quantum number 2.96, but its term type is uncertain, as it does not appear to fit into the general scheme of electronic levels. The rotation terms have been accurately evaluated for the three new bands and for three others previously described which also have the final level 2P. The molecular constants are thence determined and their relations considered. New evidence is presented which favours the view that the helium and hydrogen molecules are structurally similar. The question of a suitable criterion for distinguishing between the A and B rotational sub-states is discussed in the light of the new data.

The Saha Theory and the Conductivity of Flames Containing Alkali Metal Vapours. By H. A. Wilson, F.R.S.

Noyes and Wilson have shown that the equilibrium constants for the reaction $M = M^+ + e$ (where M denotes atom of alkali metal and e electron) can be deduced from measurements of electrical conductivity of flames at about 2000° K, and that equilibrium constants so obtained agree approximately with those calculated by the Saha theory. This determination of equilibrium constants has geen criticised by Marx, who points out that two assumptions were made which may be wrong, *viz.*, that all salt sprayed into the flame is redneed to metal vapour and that all negative carriers are free electrons. It is shown in the paper that these assumptions may be omitted without making any difference to the equation used in the calculations.

It is also shown that Bennett's results on conductivity of rubidium in flames give a value of equilibrium constant nearly equal to that given by Saha's theory, independently of the assumptions objected to by Marx; and that Gouy's results on light emitted by sodium flames require the fraction of sodium reduced to metallic state to be independent of concentration of sodium, and that it follows from this that the fraction of ions which are electrons must be independent of concentration; also that mobilities of negative ions deduced from the Hall effect and from Bennett's results are not too small to be those of free electrons.

It is also shown that the relative conductivities of alkali metals found by different observers agree approximately with those calculated on Saha's theory.

Fluid Resistance to Moving Spheres. By R. G. Lunnon. Communicated by T. H. Havelock, F.R.S.

By timing the falls of metal spheres in water, through distances up to 2 metres, the resistance of a fluid at high speeds has been measured both for accelerated and for uniform motion.

(1) The variation of resistance with speed is shown on a graph of the resistance coefficient ($\psi = F/\rho v^2 d^2$) with the Reynolds number ($R = vd/\nu$). The results are in good agreement with previous measure-

ments in which air was the fluid concerned.

(2) During accelerated motion, the resistance is increased in a regular way, which can be described approximately in terms of a carried mass, varrying from one-half to twice the mass of the displaced fluid.

(3) The effect of cylindrical walls has been measured.

(4) The motion of the fluid behind the sphere is described.

A Redetermination of the Velocities of Particles from Radium C, Thorium C and C'. By G. H. Briggs. Communicated by Sir Ernest Rutherford, Pres.R.S.

A redetermination by the magnetic deflection method of $H\rho$ for α particles from radium C gives 3.993×10^5 E.M. Units. Using the theoretical value of E/M deduced from electrochemical data, the velocity is 1.923×10^9 cm. per sec. The corresponding values found by Rutherford and Robinson were 3.983×10^5 and 1.922×10^9. Velocities for thorium C and C' were found to be 1.704×10^9 and 2.053×10^9. For other substances emitting α particles velocities are deduced from ranges and the author's work on decrease of velocity of α particles from radium C.

THE OPTICAL SOCIETY.

At the Annual General Meeting of the Optical Society, held on March 8, the following officers and members of Council were elected : —

President—Dr. R. S. Clay; *Vice-Presidents*—Mr. D. Baxendall, Mr. H. H. Emsley, Mr. J. Guild, and Mr. F. C. Watts; *Hon. Treasurer*—Major E. O. Henrici; *Hon. Secretaries*, — Professor A. F. C. Pollard and Mr. W. B. Coutts; *Hon. Librarian*—Mr. J. H. Sutcliffe; *Editor of Transactions*—Dr. J. S. Anderson; *Members of Council*—Mr. O. Aves, Mr. T. Chaundy, Dr. C. V. Drysdale, Mr. E. F. Fincham, Mr. E. T. Hanson, Instr.-Comdr. N. M. S. Langlands, R.N., Professor A. O. Rankine, Mr. H. C. Raxworthy, Mr. J. Rheinberg, Mr. R. S. Whipple, Mr. A. Whitwell, Colonel H. S. L. Winterbotham.

Dr. R. S. Clay delivered his Presidential Address on "The Stereoscope." In the course of his address he showed that it was Sir Charles Wheatstone who first conceived the idea of presenting a pair of stereoscopic drawing to the right and left eye respectively and so producing the illusion of an object in relief. From a letter written by R. Murray of Messrs. Murray and Heath, it was shown that Wheatstone had had apparatus made for this purpose, using both prisms and mirrors, as early as 1832, though his actual paper on "Contributions to the Physiology of Vision" was not presented to the Royal Society until 1838. In 1840 Wheatstone had induced Fox Talbot (one of the inventors of photography) and Collen (one of its first exponents) to use the new art for taking stereoscopic pictures.

Brewster in 1849 devised a more convenient, lenticular instrument, which was introduced and popularised through the agency of Duboscq at the time of the 1851 Exhibition. Brewster endeavoured most unfairly to belittle Wheatstone's share in the invention by letters to the *Times*, articles in the *Philosophical Magazine* and other papers, and especially in his book on the stereoscope.

Models reproducing two of Dr. R. Smith's experiments, described in his "Compleat Systems of Optiks," Elliott's Stereoscope and several of Wheatstone's experiments were passed round.

By the courtesy of the Delegacy of King's College several of Wheatstone's original stereoscopes were exhibited. Among these was a "Moving Pecture" apparatus, in which a series of stereoscopic pictures of a French soldier presenting arms, mounted on a drum, was rotated by an ingenious intermittent motion.

Also a large number of early interesting stereoscopes were loaned from the Science Museum. Among there was a beautiful example of Swan's "Cube" from the Court Collection, in which by the combination of two stereoscopic pictures on the back and side of the "cube" an image of a lady appeared in stereoscopic relief within the glass.

A large number of beautiful slides were shown, including early drawn ones, Daguerreotypes—coloured and otherwise—Collodion, curious crinoline and other subjects, instantaneous pictures of breaking waves by Breeze taken about 1860, and some very artistic modern slides all selected from the collection of Mr. Thos. H. Court, were also exhibited in three magazine stereoscopes.

Two original Wheatstone pseudoscopes were shown, by which a rotating glass beaker suspended from a string viewed from one direction appeared to be changing its shape as it rotated; viewed from another direction it appeared to be turning over and over about a horizontal axis, whereas it was really rotating about a vertical one.

A vote of thanks to Dr. Clay for his address and for providing the members of the Society with a unique opportunity for seeing many valuable instruments illustrating the history of the Stereoscope was moved by Professor Rankine and carried with acclamation.

THE INSTITUTE OF METALS.

At the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W1.

Tuesday, May 8, at 8 p.m. -- The Eighteenth Annual May Lecture will be delivered by Prof. Cecil H. Desch, D.Sc., Ph.D., F.R.S., on "The Chemical Properties of Crystals."

NOTICES OF BOOKS.

Coloured Thinking and other Studies in Science and Literature. By D. F. Fraser-Harris, M.D., D.Sc., F.R.S.E. Pp. 270. Price 5s. net. London : George Routledge & Sons, Ltd., Carter Lane.

The author contends that there is nothing in science to render it incapable of being expressed in clear terms provided an author takes the necessary trouble. The author's exposition of this coloured thinking theory is ingenious, but of an argumentative nature. He is probably more successful in his "Childishness in Adult Life" chapter, although even here it would be hard to convince the person of the non-intervention of some malevolent obstructive power, who experiences a long unbroken sequence of wrecking interventions. "Poetry and Science" is an interesting chapter. Several of the chapters are reprints of interesting articles that have appeared comparatively recently in certain magazines. The work is varied and interesting, and such as one could take as a companion on a railway journey.

Colloid Symposium Monograph. Being Papers presented at the Fifth National Symposium on Colloid Chemistry, University of Michigan, June, 1927. Edited by Harry Boyer Weiser (Prof. of Chemistry, The Rice Institute). Pp. 394. Price $6.50. New York ; The Book Dept., The Chemical Catalog Company, Inc., 419, Fourth Avenue at 29th Street, U.S.A.

The Symposium, at which the various papers included in the present handsome volume were presented, was sponsored by the Colloid Division of the American Chemical Society, and hence the volume can be considered as a quasi-official volume. Professor H. R. Krugt, of the University of Utrecht was, we notice, the guest of honour on this occasion, and it was a fitting introduction to the proceedings that he read a paper on "Unity in the Theory of Colloids." Judged by the resolution of thanks passed by the 200 guests present, the hospitality extended to them was on a considerate scale. Altogether 24 papers were presented and the ground was pretty completely covered. There is given at the end of the volume both author and subject indices, though this was scarcely necessary in face of the contents page published at the beginning of the work. The volume will be found very useful for reference by students, lecturers, and others.

The Mystery and Lure of Perfume. By C. J. S. Thompson. Pp. xvi + 247. London : John Lane, The Bodley Head. 1928. Price 10s. 6d.

Whilst it is only within the last century that chemists have been seriously interested in the preparation and imitation of perfumes these have attracted general attention from the earliest times. Indeed, perfumes and cosmetics are referred to in the earliest accounts of past civilisations—Egyptian, Greek, Roman and Oriental. Thus, Theophrastus in the fourth century B.C., alludes to many plants which he states were used for their perfumes. He suggested that perfumes should be judged by their lasting qualities.

It is noteworthy that the early English perfumes, lavender and rosemary, which have always been made by a kind of steam distillation process, are still most highly esteemed. The word is derived from the Latin *per fumum*, in allusion to the odours produced on burning.

In addition to the multitude of plant perfumes, there are three of animal origin. These are musk, from the musk deer; ambergris (now known to be a morbid secretion of the sperm whale) and civet.

It appears that the Greeks used fixed oils and wine as solvents or vehicles for the perfume. The process of enfleurage, *i.e.*, extracting the essence with oil, as practised in the Riviera district was known to the Romans. The Arabs were probably the first to practise the distillation processes with steam as, for instance, with rose water.

Then, in the Middle Ages came the blending of perfumes, and the preparation of *Eau de Cologne*, etc.

Most of Mr. Thompson's book is descriptive and historical but he includes an important chapter on artificial and synthetic perfumes in which allusion is made to the remarkable syntheses made in organic chemistry of such compounds as ionone, vanillin, coumarin and artificial musk. In one case at least (almond oil), the laboratory product has displaced the natural body.

Mr. Thompson's volume is most entertaining and only one trivial criticism can be made, namely, that it would have been well to give the botanical names and orders of the plants mentioned. The book should appeal to a wide circle of general readers.

J. G. F. D.

The Composition of Water. By J. R. PARTINGTON. Pp. VIII. + 106. London: G. Bell & Sons. 1928. Price 1s. 6d.

In this little volume Prof. Partington traces the development of scientific knowledge concerning the chemistry of water. He recalls the early views of Thales of Miletus that "all things come from water," and quotes the same experiment of van Helmont as I give in *A Brief Outline of the History of Science* (THE CHEMICAL NEWS, 1925. Van Helmont's introduction of the term "gas" paved the way for Cavendish's work on the synthesis of water in which he showed that two volumes of hydrogen unite with one of oxygen. Reference is also made to Lavoisier's contribution to this study in which he and Meusnier combined 22.92345 (!) volumes of hydrogen with 12 of oxygen. The most refined researches of Scott, and Burt and Edgar show that 1 vol. of O combines with 2.0028 vols. of H; whilst Morley found in 1895 that by weight, 15.879 gr. O combined with 1 gr. H.

Prof. Partington also deals adequately with the contributions of Priestley, Dumas, Berzelius and others to the development of modern knowledge concerning the composition of water.

The author and publishers are to be congratulated upon this 1s. 6d. monograph, which deserves the widest publicity among teachers and scientists generally.

J. G. F. D.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

8,083.—I. G. Farbenindustrie Akt.-Ges. Recovery of organic acids.—March 16th.

7,647.—Nitrogen Engineering Corporation.—Synthetic production of ammonia. March 12th.

7,695.—Hartley, G. S.—Crucible holder and stand. March 13th.

8,086.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of acetone. March 16th.

Specifications Published.

286,796.—I. G. Farbenindustrie Akt.-Ges. Manufacture of new aralkylated unsaturated fats and fatty acids and their sulphonic acids.

286,850.—British Dyestuffs Corporation, Ltd., Saunders, K.H., and Wignall, H. — Manufacture of ethylene glycol.

277,932.—Nouvelles Industries Chimiques Soc. Anon.—Recovery of nitrogen and acetone from vinasses and molasses.

274,519.—Soc. des Etablissements Barbet. —Process and apparatus for the extraction of glycerine from distillery vinasses.

286,980.—Soc. Generale Metallurgique de Hoboken. — Manufacture of sulphuric acid.

Abstract Published.

284,208.—Sulphuric acid.—Soc. Generale Metallurgique de Hoboken, Hoboken-lez-Anvers, Belgium.

In preparing sulphuric acid from cold sulphurous gases, denitration of the acid is effected by a stream of hot sulphurous gases in a tower packed with inert filling materials, preferably consisting of irregular pieces of an average size of less than 40 mms. The hot gases are obtained either by heating a portion of the cold gas or directly by roasting pyrites, and the stream of gas after use is added to the cold gases.

The Latest TRADE MARKS

. This list of Trade Marks of interest to Readers has been selected from the Official *Trade Marks Journal*, and is Published by permission of the Controller of His Majesty's Stationery Office.

CAROFAX.

487,495.—Chemical substances prepared for use in medicine and pharmacy.—The Wellcome Foundation, Ltd., 67, Holborn Viaduct, London, E.C.1. March 21st.

MULSAGAR.

486,901.—Chemical substances prepared for use in medicine and pharmacy.—Burgoyne, Burbidges and Company, Limited, High Street South, East Ham, London, E.6. March 21st.

CRAIDON.

488,211.—Chemical substances prepared for use in medicine and pharmacy.—Cecil George Crawford and Robert William Dunn, trading in Co-partnership, 526, Bank Chambers, 329, High Holborn, London, W.C.2. March 21st.

FRANBAR.

Registration of this Trade Mark shall give no right to the exclusive use of the letter "F" or of the letter "B."

488,148.—Chemical substances prepared for use in medicine and pharmacy.—*Francis, Bernard Curran, 29, Fossgate, York.* March 21st.

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CONTENTS. PAGE.

The Rotations of the Orbits of Six Planets, and Cognate Phenomena ... 225
By F. H. Loring.
Steam Accumulator Developments ... 229
By a Well-Known Engineer.
Water-Power and Industry ... 230
International Congress of Tropical Medicine ... 231
Coal, Iron and Steel ... 232
Tropical Hygiene Societies ... 234
Proceedings & Notices of Societies :—
The Chemical Society ... 235
Geological Society ... 237
Mineralogical Society ... 237
Notices of Books ... 239
New Patents ... 239
New Trade Marks ... 240

THE ROTATIONS OF THE ORBITS OF SIX PLANETS, AND COGNATE PHENOMENA.

By F. H. LORING.

The advance of Mercury's orbit has long been known, as was the fact that it was *slightly in excess of the theoretical value* due to the perturbations of the other planets, which effect has been fairly accurately calculated from astronomical observations. This remarkable discovery was made by the French astronomer Leverrier, and he found the extra advance to be 38 seconds of arc per century. This was confirmed by a later and more precise determination by Newcomb.

H. N. Russell, R. S. Dugan, and J. Q. Stewart in their "Astronomy" (which appeared in 1927, being a revision of "Young's Manual of Astronomy"), vol. I, p. 806, give this observed excess as $+40''.1 \pm 1''.4$, per century, this being generally referred to as the "advance of the perihelion of Mercury."

According to the theory of relativity, Mercury should travel out an advancing orbit, the amount of the advance being calculated from Einstein's well-known equation. The constants in this equation are accurately known, for it can now be said that the velocity of light is closely determined owing to Michelson's recent fine measurements, the value being 299796 kilometres per second *in vacuo* (Michelson in his "Studies in Optics," 1927, p. 137, intimates that the error is reduced to 1 in the last digit, which indicates a remarkably great achievement). The writer has attempted to calculate this constant from

Rydberg's *constant* $R_\infty = 109737.37$ *and*

Planck's constant $h = 6.556 \times 10^{-27}$, according to the equation

$$R_\infty/(24 \times 10^{-33}/h) = c, \text{ in cms.}$$

See *Chemical News*, 1928, cxxxvi, 33.

The value of c so obtained is listed below in km. measure (larger c), but it is not appreciably higher than Michelson's new value; and, as will be seen presently, it does not help to improve the agreement between the Einstein calculation of the turning of Mercury's orbit and the measured value above quoted.

The calculation is here given practically in full. The other constants are taken from "Astronomy," referred to above.

The Einstein equation is—

$$\delta\omega = 24\pi^3 a^2/C^2T^2(1-e^2).$$

24 = numerical factor.

π^3 = 31.006276680.

a = semi-major axis of the orbit of Mercury × Earth's mean distance = 0.387099 × 1.4945 × 10^8 in kilometres = 57851945.55. This value squared is 3346847604000000 = a^2.

C = velocity of light *in vacuo* in kms. per second = 299796.40858. This value squared is 89877886567 = C^2.

e = Mercury's eccentricity = 0.20562*. This value squared is 0.042279584 = e^2.

$1-e^2$ = 0.957720415.

* In the *B.A.A. Handbook* this figure is given as 0.2056193.

T = Mercury's sidereal period in mean solar days which is 87.96926, but this must be converted into seconds before squaring. It should be explained that the sidereal period, or astronomical period, is the time taken by a planet to revolve round the sun, as measured from its crossing of the 'point' of a fixed star (one so far away as to be *stationary for astronomical observational purposes*) as seen from the sun. This period is expressible in terms of solar days (see table). To convert the sidereal period of revolution into seconds, the value in days given (see table) has to be multiplied by the number of seconds in the day, namely, 86400; the variable in these cases not being the second or the day as such, but the number of days including *a fraction thereof.* Therefore 87.96926 × 86400 = 7600544.064. This value squared is

$$57768270000000 = T^2.$$

$\delta\omega$ ... This value (see explanatory notes) as obtained by the above equation when using the foregoing values has to be multiplied by (365.25636042)/(87.96926) to obtain the *year value*, but not yet seconds of arc. The foregoing division gives the value 4.1520908. Returning to the main calculation, the value obtained by this modification has to be divided by 0.000004848136—taken as the length of an arc of one second when the radius is unity, which is: 2π/(*number of seconds in a circle*); or, π/648000—the answer being the advance of the perihelion of Mercury's orbit in one year in seconds of arc. As the value is given per century, this year value has to be multiplied by 100. Carrying out the complete computation, the final value is + 42.″8951.

Referring to the values above, it will be obvious that it is not necessary to make the computations with quite so many significant figures, but the rounding off can be done by cancelling out when the above values are entered on each side of the solidus, before performing the final multiplications.

It must be remembered that the calculation of the perturbations, referred to at the outset,* is a highly intricate procedure, and even if no small errors are present, the determination by Newcomb in 1895 of + 41.″6 ± 1.″4—or selecting the revised value + 40.″1—is not sufficiently different from the Einstein value here calculated to affect the validity of the theory of relativity. No great importance need be attached to *plus* and *minus* signs after determinations; for, as a rule, they are of too limited a significance to convey any meaning as to the precision of the value.

It should be noted that the use of kilometres in the equation instead of centimetres is quite in order, because the km. values occur on each side of the solidus.

The question as to the accuracy of the various constants entering into the equation has to be considered in judging the closeness of the final value. P. R. Heyl (*Proc. Nat. Acad. Sci.*, 1927, XIII, 601) has redetermined the gravitational constant which came out very near to the previously accepted value. In fact it almost looks as if the true value could be taken as 2/8 × 10^{-7} C.G.S.U., with a minimum of error. This value might introduce a slight modification of some of the astronomical values directly or indirectly involved. In the *B.A.A. Handbook* Boys' value is given as 6.66 × 10^{-8} in C.G.S.U.

Whatever minute changes may be made in the future the values have a relative relation that cannot materially change, so it is of interest to note the rotations of other planets than Mercury. The following table shows the computations made for 6 planets. To complete the survey some empirical relations are given at the conclusion.

* These "are sensibly the same as on the new theory [of Einstein] as on the old, so that the agreement between observation and the new theory is striking."—"Astronomy" (*loc. cit.*).

Planet.	Semi-Major Axis of Orbit.	Sidereal Period (Mean Solar Days)	Eccentricity	Rotation″ per Century
MERCURY	0.387099	87.96926	0.20562	42″.8951
VENUS	0.723331	224.7008	0.00681	8.6074
EARTH	1.000000	365.25636042	0.01674	3.8311
EROS	1.458296	643.230	0.22297	1.5694
MARS	1.523688	686.9797	0.09333	1.8482
JUPITER	5.202803	4332.588	0.04837	0.0622

In the *Chemical News* during the year 1923, and of Jan. 4, 11, 25, Feb. 8, 1924, it was shown by the present writer that a series of numbers called "B" numbers (not to be confused with A and B divisions of numbers elsewhere used) were derivable from the planetary and satellite distances; also partly derivable from the first Balmer lines of hydrogen; and the periodic classification of the elements afforded a closely corresponding set of numbers. It was afterwards shown that the *atomic numbers* of the *inert gases* could be derived also from the same B numbers, or *vice versa*. Summing this up the following scheme and equations give the best representation of this earlier study.

3	×	1	-	1^2	=	2	=	He
7	×	2	-	2^2	=	10	=	Ne
9	×	3	-	3^2	=	18	=	Ar
13	×	4	-	4^2	=	36	=	Kr
21	×	3	-	3^2	=	54	=	Xe
45	×	2	-	2^2	=	86	=	Rn, Tn, An
119	×	1	-	1^2	=	118	=	Limiting member by Bohr

The equation for deriving B numbers above (3, 7, 9, etc.), which includes in square brackets the well-known one for the exact atomic numbers of the inert gases, is

$$\{[2 \times (1^2 + 2^2 + 2^2 + 3^2 + 3^2 + 4^2 + 4^2)] + n^2\}/n$$

= B numbers, when $n = 1, 2, 3, 4, 3, 2, 1$, taken progressively, and the equation worked in corresponding steps by stopping off at each squared term. The atomic numbers are therefore given by the equation :—

$$nB - n^2 = \text{Atomic Number.}$$

Now making use of a series, 2, 4, 8, 16, 32, 64, 128—*i.e.*, a geometrical progression series—and the above B numbers, the following close approximations to the Einstein rotations are obtained, the B numbers being associated with the same planets as hitherto.

S. & U.	Jupiter	Asteroids	Mars	Earth	Venus	Mercury
2/119	4/45	8/21	16/13	32/9	64/7	128/3
—	0.0888	—	1.2308	3.5555	9.1428	42.6666
—	0.0622	—	1.3482	3.8311	8.6074	42.8951
Diff. ...	-0.0266	—	+0.1174	+0.2756	-0.5354	+0.2285
			Net difference	= 0.06.		

The asteroids make a break in the continuity of the scheme, as possibly at one time there was a small planet at the proper place which exploded, or suffered in its parts a series of explosions. This appears to be borne out by the studies of K. Hirayama (see *Sci. Abs.*, 1923, xxvi, 943) who has shown that there are five asteroidal groups, with about 30 members in each group, which satisfy the dynamic condition that they must intersect at the point or region at which the explosion took place.* On this account Eros, which is one of the

* This statement calls for a more specific and presumably more accurate one which appears in "Astronomy" on page 357 as follows :— "If such a catastrophe should occur, and if the fragments were dispersed with relatively small velocities, their orbits would remain very similar, having nearly, though not quite, the same period, eccentricity, and inclination. At first they would all pass nearly through the point of explosion, but the perturbations, due mainly to Jupiter, would gradually shift the orbits, and after a few hundred thousand years this would no longer be true. It can be shown, however, that these perturbations would not alter, in the long run, the mean distances of the planets or their inclinations to the plane of Jupiter's orbit. Moreover, although the eccentricities and longitudes of perihelion would be altered by perturbations, they would change in such a manner that the centres of their orbits, when plotted in space, would all be equidistant from a certain definite point on the line joining the sun with the centre of Jupiter's orbit."

asteroids has to be left out of the present scheme.

Eros, as insignificant as it is from the point of view of a planet, has afforded a very accurate determination of the solar parallax; but it is questionable whether such a minute turning as here given (1″.5694) can ever be measured with a small enough error to be of service in connection with the subject of this article.

On January 30, 1931, Eros will again be fairly near to the earth when further measurements will be made.*

It must be remembered that the values are for 100 years. In proportion as the orbits approach a circle it becomes increasingly difficult to measure the advance of the orbit, and this has to be taken into account as well as the expected amount of the extra advance, or difference; and, besides, the perturbations due to the outlying planets (all others) make the problem complex, so that highly accurate measurements and computations comparable with the calculated values above given, are not at present possible.

Explanatory Notes.

Einstein's equation gives the answer in radians per revolution. At the finish, instead of dividing by 0.0000048481368, the value may be multiplied by the number of seconds in one radian, *viz.* :—*206264″.80625 (the foregoing* value into unity, *i.e.*, reciprocal) but the answer will, of course, be the same. It is to be noted that 0.000004848136 is the sin of 1″.

The B numbers as applied to the distances of the planets and their satellites are *less in error than was originally supposed*, because it is necessary to consider some planets and some satellites as pairs competing for the same path, so that harmonic mean distances have to be taken. This is not so artificial as may seem at first sight, for by adopting Jeans' theory of planetary evolution along two arms of a spiral structure,† the planets have to be arranged in alternate sets, or two sets, arranged side by side, but with the pairs just mentioned brought together—apart from the asteroids one pair in this case, and one planet under the other. When this is done the characteristics of all the planets harmonise very well in paired relationship, and a sort of periodic table of the planets thus constructed brings out these relations clearly. There is a blank opposite to or facing Mercury, but no B number for this place unless it is nought, or a starting value near to unity. This has, however, suggested that another planet between Mercury and the sun had existed but had exploded as in the probable case of the asteroids. No bodies have been observed crossing the sun's disc, so that they must be less than 30 miles in diameter if they exist. That such a planet could have set Mercury's orbit turning so that the effect is still in *some* evidence seems highly improbable from dynamic considerations. It is of passing interest, nevertheless, as there is a slight discrepancy in the case of Mercury, but this is probably due to experimental error.

Returning to the spiral structure with alternate sets of B numbers, this procedure has the advantage of avoiding the overlap of the asteroids for greater separation distances are thus obtained. This then helps

* It is probable that as a result of these measurements the astronomical unit will be readjusted, for the measurements will be mainly concerned with the solar parallax.

† Strictly speaking the Chamberlin-Moulton-Jeans hypothesis: a passing star having drawn out two jets of matter from the sun which broke up into the planets, the largest being about midway. It is supposed that the two stars swung round each other when this event took place. The two stars hypothesis may eventually be displaced by one based upon a single star (sun) acting as in the case of the radio-atoms when they expel α and β particles. In fact there is a little evidence that such was the case, the satellites being due to a similar explosion or ejection; but, a duality of action seems necessary. It may be of interest to note that from the B numbers and a progressive difference series it is possible to calculate all the planetary periods except that of Neptune. These periods agree very closely with the proper values. In this way the planet representing the asteroids may be shown to have a value of 4.011 *sidereal* years. According to the series above giving the Einstein rotations per century the value for this at-one-time planet comes out at 8/21 = 0″.381. From the tabular classification its general properties, size, mass, *etc.*, would have been near to that of Mars (see following remarks).

to throw the pairs relatively nearer together and gives some measure of plausibility to the assumption that they do in a sense compete for the same path, whatever this may mean, and this justifies taking the *harmonic means in accordance with the* B numbers whenever necessary. Uranus and Saturn form a pair, their joint B number being 119. Neptune appears to be out of the number scheme, but the equation above for the B numbers may require extension. It is to be noted that some of the B numbers tend to become harmonic mean values; *i.e.*, $2AC/(A+C)=B$. Neptune, however, fits into the tabular scheme mentioned above as it falls opposite to Uranus. The mean diameter of Neptune is 31000 miles and its density 17.6. Uranus has a diameter of 31700 and a density of 14.66. Venus and the earth are paired in this way and the agreement here is equally good. In fact the agreements are good enough to give strong evidence of the dual production in the manner indicated above, and, moreover, the dual nature of the equation is suggestive. If there is a planet beyond Neptune then Jupiter falls midway as Jeans has indicated should be the case. The other side of the table requires a most distant planet which would have a B number of about 800. See discussion of ultra-Neptunian planets in "Astronomy."

The main feature of this treatment is to give practical details in the computation that are not given in text-books or publications generally. For example, Einstein's equation is not given at all in "Astronomy," and when it is given in books on relativity the astronomical details are passed over as understood. Of course, the introduction of B numbers in this connection is new.

STEAM ACCUMULATOR DEVELOPMENTS.

AN IMPORTANT ADVANCE FOR THE CHEMICAL INDUSTRY.

BY A WELL KNOWN ENGINEER.

There is little doubt that one of the most striking advances of recent years in the world of steam generation is the solution by Dr. Johannes Ruths of Stockholm, of the very old problem of Steam storage, that is "total" accumulation sufficient to supply say the industrial establishment for an hour or two, say 50,000 to 150,000 lbs. of steam in a single accumulater. The storage of steam is a subject of direct importance to most industries, but especially for chemical works and similar establishments, and the accumulator is now being developed in Great Britain on extensive lines.

With this object there has been formed a new Company, Ruths Steam Accumulators, Ltd., with registered offices at Africa House, Kingsway, W.C.2. The Board consists of Mr. F. E. Powell, Chairman of the Anglo-American Oil Co., as Chairman, supported by Mr. A. J. T. Taylor as Managing Director, Sir Alexander Kennedy, Chairman of the Fairfield Shipbuilding Co., Ltd., Dr. Johannes Ruths of Stockholm, Mr. J. B. E. Dahlerus, Managing Director of Electrolux, Ltd., Mr. J. Howden Hume, of Messrs. James Howden and Co., Ltd., and Mr. W. S. Eyre, a Director Messrs. Grace Bros. Ltd., of London.

It may be stated also that in 1925 there was formed Fairfield-Howden-Ruths Steam Accumulators Ltd., a pioneer company, which, however, was not a sales organisation, but had as its main object, to demonstrate in various "key" industries the value of the invention. This prelinminary work has been caried out with great success, and there are 15 representative plants operating in Great Britain, including Scottish Dyes Ltd., Grangemouth, near Edinburgh, the Provan Chemical Works of the Glasgow Corporation, William Forrest and Sons, (Paisley), Ltd., glue and bone meal manufacturers, and the Anglo-Scottish Beet Sugar Corporation at Colwick, Nottingham. Also over 850 Ruths Accumulators are now at work throughout the world, in Canada, Sweden, Finland, Germany, France, Roumania, Czecho-Slovakia, and Belgium, in all kinds of industries, including chemicals, iron and steel, mining, paper, wood pulp, textiles and food products, to mention a few cases only. The essential principle of the invention is of course well-known to be that of a large cylinder nearly filled with water into which all the surplus steam is blown, while giving automatically any desired amount of steam by re-evaporation of part of the water, due to difference in steam pressure between the outlet main and the accumulator. In this way the boiler plant is allowed to function as a generator only at one steady load, giving maximum thermal efficiency under ideal conditions in a manner impossible with the ordinary plant, struggling to operate both as a steam generator and a steam accumulator. Finally it may be stated an important catalogue, a really scientific treatise on the subject has now been issued.

WATER-POWER AND INDUSTRIES.

By R. H. DEAN, of Nesbitt, Thomson & Co., Montreal.

(*Reprinted from " Canada."*)

Of the Provinces of Canada, Quebec has the most turbine horse-power installed, and still has the greatest resources of undeveloped water-power. In power, Quebec is the richest of the Canadian Provinces. And power, because it is at once the motive force, and the magnet for industry, is perhaps the most valuable heritage which nature can give to a Province.

Quebec's relation to the rest of Canada can most graphically realised by a consideration of the figures published by the Dominion Water Power and Reclamation Service. Calculating all available water-power, whether utilised or still unclaimed, at ordinary six months flow, and at 80 per cent. efficiency, the leading Provinces rank as follows :—

MANITOBA POWER COMPANY'S DAM AT THE GREAT FALLS OF THE WINNIPEG RIVER, MANITOBA.

Photograph : Royal Canadian Air Force.

	Horse-power.
Quebec	11,640,052
Ontario	6,808,190
Manitoba	5,769,444
British Columbia	5,103,460
Saskatchewan	1,087,756
Alberta	1,137,505

TURBINE INSTALLATION—LEADING PROVINCES.

Quebec	1,915,443
Ontario	1,790,588
British Columbia	460,562
Manitoba	227,125
Nova Scotia	65,702
New Brunswick	47,231

UNDEVELOPED HORSE-POWER—LEADING PROVINCES.

Quebec	9,724,602
Manitoba	5,342,319
Ontario	5,017,602
British Columbia	4,642,898
Alberta	1,103,398
Saskatchewan	1,087,721

The available hydroelectric power is, therefore, not much more than 20 per cent. developed in Quebec; and yet, as we shall show later, that 20 per cent. development has been of inestimable value to us. Think what the future may hold!

Quebec has a greater *per capita* turbine horse-power installation than any country in the world save one. For every 1,000 people there is 703 h.p. of "white coal" available. According to the figures of the Dominion Water Power and Reclamation Service, the average for Canada is only 485 h.p. The leading countries rank as follows:—

TURBINE HORSE-POWER INSTALLED PER 1,000 OF POPULATION.

Norway	868
Canada	485
Switzerland	472
Sweden	268
U.S.A.	108
France	108
Italy	71
Japan	51
Germany	19

Quebec's per thousand installation exceeds that of such wellestablished countries as the United States by 595 h.p., France by 622 h.p., and Germany by 684 h.p. There is little wonder then that, as the Minister of the Interior once said, water-powers have rendered industrial structure largely inde-

GENERAL NOTES.

TENDERS FOR NORWAY.

We are advised by the Commercial Secretary at Oslo (Mr. C. L. Paus, C.B.E.), reports that District Inspector of Customs in Oslo Customs district is requesting tenders for 9,000 kilograms of wood alcohol and 2,2000 kilograms of pyridine for denaturing spirits.

Tenders, accompanied by samples, are to reach the District Inspector not later than April 12, next. The goods are to be delivered free at the Customs House store.

CALENDAR REFORM.

The recent Pan-American conference passed a resolution urging every country to consider the simplification of the calendar and to prepare for an international conference to decide upon the best method of reform.

Acording to the International "Fixed" Calendar League, committees for the purpose are being formed by the Governments in North, Central and South America, and representative Government departments are considering the matter in Australia, New Zealand, Egypt, China, and Mexico. Mr. George Eastman, the Kodak magnate, who is one of the leading movers in the scheme, is spoken of as the probable chairman of the United States Committee.

AUTOMATIC STAMPING ARRIVES.

Nearly one thousand firms throughout the country are now using the all-British stamping meter as a means of expediting their mail. Hundreds of thousands of letters are neoposted every day, each bearing, instead of the usual adhesive stamp, an artistic printed reproduction. It is claimed for the new system that not only does it simultaneously print, at the rate of 3,000 envelopes an hour, the postage stamp, a date cancellation stamp, and (if desired) a business slogan, but it does away with the buying of stamps and, within the Post Office itself, eliminates the processes of "facing" the enevlopes and cancellation.

From the commercial standpoint, the introduction of the all-British stamp-meter is of considerable importance, because both the machine and the system have been so simplified that automatic stamping, hitherto applicable only to very large houses, is now suitable for any business house

INTERNATIONAL CONGRESS OF TROPICAL MEDICINE AT CAIRO.

The Department of Overseas Trade writes us regarding the forthcoming International Congress of Tropical Medicine and Hygiene to be held at Cairo, that the Commercial Secretary at Cairo (Mr. E. H. Mulock) has forwarded the following additional particulars regarding the exhibition to be held in connection with the Congress :—

1. It is proposed to hold the exhibition for two weeks from the opening day, the 15 December, 1928, the first of which will be during the Congress.

2. The site selected is the Royal Agricultural Society's Exhibition ground, where the central building will be adapted for the purposes of the proposed exhibition.

3. This building contains a floor area of about 1,200 square metres, but if this space is gound to be insufficient, arrangements for the use of another building will be made.

4. Exhibitors are expected to provide their own partitions and furnishings.

5. Applications for space should be addressed as indicated in paragraph 9 below.

6. Up to the present, with the exception of a very few well-known British firms, applications for space have been confined mostly to German concerns, but it is hoped that United Kingdom manufacturers of all kinds of articles connected with medicine, surgery, hygiene, hospitals, ets., will make a great effort to dominate the exhibition.

7. The majority of appplications for space so far submitted have been for areas of 10 by 10 square metres, but no limit to an exhibitor's requirements has yet been set.

Although no definite decision has yet been reached in regard to the rates to be charged for space, it has been stated by the Secretary -General that charges will probably not exceed P.50 per square metre. In the meantime, applications already received are being held up pending a decision on this point.

9. A copy of the explanatory booklet can be insected by United Kingdom associations or firms at the Department of Overseas Trade and copies may be obtained by application to the Secretary-General of the Exhibition Committe, Egyptian Faculty of Medicine, No. 1, Sharia Mazloum Pasha, Cairo.

BRITISH IRON AND STEEL OUTPUT.

Furnaces in blast at the end of February showed no change in number from the close of January, but production of pig-iron was nearly 10,000 tons smaller. The output of steel ingots and castings, on the other hand,

COAL, IRON AND STEEL.

United Kingdom.

From the available information as to furnaces in blast it appears that the average output of pig-iron in January per furnace was 3,774 tons in the United Kingdom, 5,566 tons in France, 5,628 tons in Belgium, 10,011 tons in Germany, and 16,213 tons in the United States.

France.

In January the output of coal was 4,279,700 tons compared with 4,253,000 tons in December and 4,458,000 tons a year previous. The January outputs of pig-iron and crude steel were both higher than in any month of last year. The production of pig-iron in January amounted to 796,000 tons compared with 783,200 tons in December and 702,100 tons in January, 1927.

Belgium.

The coal output for January amounted to 2,369,389 tons for 25 working days as compared with 2,321,442 tons in the previous month for the same number of working days. The January output was higher than that for any month last year with the exception of that for March, when 2,437,585 tons were raised in 26 working days. The daily outputs for January, 1928, December, 1927, and March, 1927, were 94,777 tons, 92,857 tons and 93,754 tons respectively. The pig-iron output for January, which amounted to 309,524 tons, was lower than the outputs for December and January, 1927, by 2,258 tons and 1,821 tons respectively. Furnaces in blast numbered 55, both at the beginning and end of January. The production of crude steel totalled 310,577 tons in January as compared with 305,697 tons in December and 307,566 tons a year previous.

Germany.

The January coal output amounted to 13,204,853 tons compared with 13,025,640 tons in December and 13,140,720 tons a year earlier. This output was higher than that for any month since March last, when the output (the highest of the year) was higher by 615,739 tons. The January pig-iron and crude steel outputs were both greater than the highest monthly outputs of last year. The production of pig-iron in January amounted to 1,161,269 tons compared with 1,131,203 tons in December (the highest for the year), and 1,044,113 in January, 1927. The January, 1928, pig-iron output included 208,292 tons of foundry and hematite, 725,859 tons of basic, 223,447 tons of ferro-alloys and 1,678 tons of forge pig-iron. The daily outputs were 37,460 tons in January

year earlier. Furnaces in blast numbered 116 both at the beginning and end of January. The production of steel ingots and castings was 1,445,839 tons in January compared with 1,345,703 tons in December and 1,287,392 tons a year previous.

UNITED STATES.

The bituminous coal output in January (25.3 working days) amounted to 39,472,000 tons compared with 36,854,000 tons in December (26 working days) and 50,788,000 tons (25 working days) compared with 5,386,000 tons in December (26 working days) and 5,858,000 tons in January, 1927 (25 working days). The total coal output for January was thus 44,552,000 tons, which with the exception of the October output was the highest since March last. Daily production of bituminous coal was 1,560,000 tons in January and that of anthracite 204,000 tons, the former being the highest since March and the latter the lowest since July. Pig-iron production in January amounted to 2,869,800 tons compared with 2,695,800 tons in December and 3,103,800 tons a year previous. The daily pig-iron output for January was 92,573 tons compared with 86,960 tons in December and 100,123 tons in January, 1927. Furnaces in blast numbered 185 at the end of January, a net increase of 16 since the commencement of the month.

SIAMESE FOREIGN TRADE.

The British Consul-General at Bangkok reports that according to the latest statistics available the values of imports and exports for the year ended 31 March, 1927, were approximately 196.5 million ticals and 239.8 million ticals. These figures include the overland trade on the Southern frontier, but not the trans-frontier trade with Burma and Indo-China, which is still comparatively negligible. Bangkok's share of the imports and exports amounted to $175\frac{1}{4}$ million ticals and 197.6 million ticals respectively. In other words over 85 per cent. of the whole trade of the country passes through the capital. The British Empire's share in the imports was approximately 108 million ticals of which Hong Kong, the United Kingdom and Singapore were responsible for $89\frac{3}{4}$ million ticals, 24.8 million ticals and 23.9 million ticals respectively.

SWEDEN'S COMMERCIAL PROGRESS.

Although Sweden is a comparatively small country she periodically commands attention somewhat disproportionate to her industrial capacity, writes Mr. H. Kershaw, O.B.E., British Commercial Secretary at Stockholm, in his Report on conditions in that country. This was the case, for example, when Sweden first led the way in restoring the gold standard.

She again achieved prominence in 1927 by the exceptionally satisfactory development of her trade throughout the year. For the first time since the war there was a surplus (36,457,000 kronor) of exports during the whole year 1927 (total imports, 1,575,000,000 kr., exports 1,611,457,000 kr.), as compared with an excess of imports during the corresponding period amounting to 70,290,000 kr. in 1926 and to 28,190,529 kr. in 1913.

BRITISH ENGINEER'S FOUR-LANGUAGE DIRECTORY.

The Council of the British Engineers' Association, impressed with the need for more effective polyglot propaganda, plant and accessories in the markets of the world, has decided that the Association shall undertake the publication of a comprehensive work to be entitled "The Foreign Buyers' Directory of the British Engineering and Allied Industries." In this the classified headings, explanatory matter and advertisements will appear in the one volume in English, French, German and Spanish languages.

Only British firms will be eligible to appear in the Directory, and every engineering and allied firm of company possessing the necessary qualification as a manufacturer of those products in Great Britain and Northern Ireland will be entitled, free of charge, to a three-line entry, comprising name of firm, office and works addresses, telegraphic and cable addresses, and a short description of manufactures. Firms who are qualified to appear, but who have not yet sent in particulars of their manufactures to the Association, are invited to do so at once to the British Engineers' Association, 32, Victoria Street, London, S.W.1.

BELGIUM'S HEALTHY ECONOMIC POSITION.

Within fourteen months of Belgian currency stabilisation the exchange reached the incoming specie point, and gold was being shipped from the United States to Belgium. As Mr. J. Picton Bagge, British Commercial Secretary at Brussels writes in his Report on the Economic Situation in Belgium, no words can better describe the success of the methodical efforts of the nation to consolidate the position won in October, 1926, than the statement of this bald fact.

At the time of stabilisation and during

the early months of the past year fortune dealt kindly with Belgium. The coal stoppage in Great Britain and the rise of the French franc and Italian lira had brought about a conjunction of circumstances which materially helped, in that unexpected markets were opened to Belgian industry. Such conditions were, however, recognised as fortuitous and ephemeral, and anxiety was felt as to how the country would support the burden wheu the effects of these aids had passed, and she was left face to face with the free play of economic forces.

As the months passed by, and not only the exchange remained steady, but the trade balance returns showed progressive improvement, confidence took root and gradually grew stronger. It was seen that the crisis, the natural consequence of stabilisation, through which the country had to pass while the economic system was being adapted to the new level of values, was not necessarily so terrible as had been feared, but that its severity depended in a major measure upon the will of the nation to attack the causes and thereby mitigate their influence.

BRITISH METAL CORPORATION, LTD.

This Company has had a successful year in 1927. The Directors' Report shews that the net profit for the year, after appropriating £50,000 to Reserve Account, is +145,458 19s. 11d.; there was brought forward from last year £23,277 17s. 7d., making a total of £168,731 17s. 6d.

Dividends at the rate of 6 per cent. per annum on the Preference Shares (paid less Income -Tax) absorbed £54,000, leaving £114,731 17s. 6d.

The Directors recommend a Dividend of 10 per cent. upon the Ordinary Shares (payable less Income Tax), requiring £90,000, leaving to he carried forward £24,731 17s. 6d.

The metal markets had a falling tendency during most of the year and such conditions are never conducive to active business. In the circumstances the Directors regard the results achieved as satisfactory. They are due to the widespread activities of the Corporation.

SWISS TRADE IN 1927.

Both imports and exports were larger last year than in 1926, while the adverse trade balance was reduced to 21.8 per cent. as against 23.9 per cent. in the previous year.

TROPICAL HYGIENE AND BUSINESS MEN.

The need for instruction in hygiene in the case of laymen going out to the tropics was considered at a conference recently convened by the London School of Hygiene and Tropical Medicine. The Director of the School, Dr. Andrew Balfour, presided, and, having in view both the official and economic aspect of the question, had invited to the conference representatives of Departments of State, including the Colonial Office, the India Office, the Ministry of Agriculture, and the Department of Overseas Trade, and also of the many important business organisations with interests in the tropics.

It is understood that the School authorities will, in the light of the suggestions made at this conference, now proceed to make arrangements for short courses of lectures to laymen, especially employees of business firms proceeding to the tropics, and that an announcement with regard to the provisional arrangements for the next twelve months may shortly be expected. Enquiries regarding the courses should be addressed to the Secretary, London School of Hygiene and Tropical Medicine, Malet Street, London, W.C.1.

GERMAN IMPORTS OF BRITISH COAL IN 1927.

The British Consul-General at Hamburg informs the Department that, according to the recently published Annual Report of the Hamburg Association of Importers of British Coal (excluding bunker coal), the import of such coal into Germany in 1927 was 3.27 million tons, as against 3.48 million tons in the "normal" year 1925, or about one-half the pre-war figure. The view is expressed that a revival of business is not probable under present conditions, and that the licence system under which importers were allocated the same amounts in 1927 as in 1925 should be revised.

TRAFFIC TO AND FROM THE IRISH FREE STATE.

The returns which have been furnished in accordance with Statutory Rules and Orders, 1923, No. 977, show that during 1927 333,247 passengers left the United Kingdom for ports in the Irish Free State, and that 353,935 arrived from these ports, the excess inward being 20,688. (Of these, 7,157 proceeded to places outside Europe.) As in the case of the traffic with the Continent of Europe, the passenger movement

between the United Kingdom and the Irish Free State is inclusive of persons travelling to or from other countries *viâ* United Kingdom ports. The movement over the land frontier between Northern Ireland and the Irish Free State is not included in the returns made to the Board of Trade.

BRITISH EMIGRANTS AND IMMIGRANTS.

The numbers of British subjects recorded as leaving permanent residence in the United Kingdom to take up permanent residence in non-European countries were 153,505 in 1927, 166,601 in 1926, and 140,594 in 1925. Residence for a year or more is treated as permanent residence for the purpose of this classification. Those British subjects who were recorded as leaving permanent residence in non-European countries to take up permanent residence in the United Kingdom numbered 55,715 in 1927, 51,063 in 1926, and 56,335 in 1925. Thus the total of emigrants was less in 1927 than in 1926 by 13,096, and the total of immigrants more by 4,652, aliens being omitted in both comparisons. Increases in the total number of immigrants were recorded in each quarter of 1927, while the number of emigrants was smaller in each quarter except the second. The balance of British migrants outward from the United Kingdom in 1927 (103,951, including 6,161, the balance outward of Irish Free State migrants at United Kingdom ports) corresponded closely with the outward balance of all British passengers to extra-European countries (103,603).

INSTITUTION OF GAS ENGINEERS.

On April 2 a special meeting was held at the Institution of Electrical Engineers, Victoria Embankment, to approve the terms of application for Royal Charter. In the afternoon a visit was paid to the Staines station of the Gas, Light and Coke Company for inspection of the waterless holder under course of construction, and apparatus for drying of gas.

ROYAL INSTITUTION.

A General Meeting of the Members of the Royal Institution was held on April 2, Sir Arthur Keith, Treasurer and Vice-President, in the chaid. Sir Daniel Hill, Mrs. H. O. Hamilton, B. W. Leefe, Sir William Mitchell, W. P. Paddison, and Evan Parry were elected Members.

The Friday evening discourses at the Royal Institution will be resumed on April 20, at 9 o'clock, when Sir Henry Lyons, Director of the Science Musuem, will deliver a discourse on "Heirlooms of Industry," in the Science Museum. Succeeding discuorses will probably be given by Professor A. M. Tyndall, the Right Hon. R. McKenna, Professor Doris MacKinnon, Morley Roberts, A. C. Egerton, C. Leonard Woolley and Professor G. P. Thomson.

Proceedings and Notices of Societies.

THE CHEMICAL SOCIETY.

Papers read on Thursday, March 29 :—

The Chemistry of the Three-Carbon System. α-cycloHexylidene-Acetone and Methyl Ethyl Ketone. By A. H. Dickins, W. E. Hugh and G. A. R. Kon.

The Nitration of Aromatic Thiocyanates and Selenocyanates. By F. Challenger and A. T. Peters.

The chief product of the nitration of *o*-tolyl thiocyanate is 5-nitro-*o*-tolyl thiocyanate, whilst the 4-nitro-derivative is formed in much smaller amount. Phenyl selenocyanate gives on nitration chiefly *p*-nitro-, with some *o*-nitro-phenyl-selenocyanate. *p*-Tolyl selenocyanate with nitric acid (*d* 1.5) at $-10°$ gives 2-nitro-, with some 3-nitro-*p*-tolyl selenocyanate, whilst under other conditions the corresponding nitrodiselenide and nitroseleninic acids are formed. *p*-Chlorophenyl selenocyanate, with nitric acid (*d* 1.5) at $-10°$ or $-25°$, gives *p*-chlorobenzeneselenic acid and some 2-nitro-*p*-chlorophenyl selenocyanate. With *p*-bromophenyl selenocyanate and nitric acid only the selenic acid can be isolated.

When 3-*nitro-p-bromo- or -chloro-aniline* is diazotised and treated with cuprous or ferric thiocyanate the corresponding thiocyanate is obtained, but is accompanied by much nitro-*p*-dithiocyanobenzene. This apparently arises by an intramolecular transformation analogous to that whereby *p*-chlorobenzenediazonium thiocyanate yields *p*-thiocyanobenzenediazonium chloride.

Effects Induced by the Phenyl Group. Part I. The Addition of Polar Reagents to Styrene and the Behaviour of the Halogenated Ethylbenzenes. By F. Ashworth and G. N. Burkhardt.

The interaction of styrene with hydrogen bromide, ammonium hydrogen sulphite, or thiophenol, and of ω-bromo-ethylbenzene, β-bromoethylbenzene, and βω-dibromoethylbenzene with aqueous alcoholic potassium hydroxide has been studied. The ad-

dition of hydrobromic acid and ammonium hydrogen sulphite is in accordance with the Markownikoff rule and requires negative free affinity on the ω-carbon atom in styrene. Posner's (*Ber.*, 1905, xxxviii, 646) conclusion that the addition of thiophenol to styrene takes place quantitatively in the opposite sense to that of hydrobromic acid is confirmed. This reaction is greatly accelerated by the action of light and greatly retarded by the presence of small amounts of piperidine. The addition may take place by the increasing of the electronic shell in the sulphur atom. The relationships of these reactions to various other effects of the phenyl group are discussed.

On Selenium Tetrafluoride. By E. B. R. Prideaux and C. B. Cox.

Lebeau's product (*Compt. rend.*, 1907, cxliv, 1042) might have contained the hexafluoride, oxyfluoride and even the dioxide dissolved in hydrofluoric acid. Selenium tetrafluoride has now been prepared by the action of selenium tetrachloride on silver fluoride, a method which precludes the presence of water, hydrofluoric acid, or a higher fluoride. The physical properties of the tetrafluoride are distinct from those of the oxyfluoride. The chemical reactions of the two compounds are similar, but not identical.

The Laws of Aromatic Substitution. Part VIII. By B. Flurscheim and E. L. Holmes.

To examine the effects of "negative" lateral substituents on nuclear substitution, the complete series of toluenes substituted by chlorine and/or carbethoxyl, together with two bromo-compounds, has been quantitatively investigated.

The results prove the existence of a polar effect on substitution even in *m-* and *p-*compounds (Robinson), but also of an alternating effect (Flürscheim), which tends to reverse the order in which the relative polarity of chlorine and carbethoxy (as evidenced by the dissociation constants of the corresponding *m-* and *p*-substituted aromatic acids and bases) would produce *m*-substitution. The fundamental nature of chemical polarity and polar effects is discussed.

Ethyl phenylmethanetricarboxylate, obtained from sodium phenylethylmalonate and ethyl chloroformate, boils at 154-155°/1.5 mm. Ethyl phenylchloromalonate, obtained by chlorination of ethyl phenylmalonate, boils at 143-144°/2 to 1.5 mm.

SOCIETY OF GLASS TECHNOLOGY.

The President, Mr. Walter Butterworth, Senr., presided at the meeting of the Society of Glass Technology held in Leeds on March 21, 1928. Two papers were presented and discussed :—

A Method for the Determination of the Probable Durability of Tank Blocks. By E. J. C. Bowmaker, B.Sc.

Two methods were described.

1. The specimen was ground to a smooth surface (the edges were bevelled), dried and weighed. After three hours' boiling in an acid mixture (3 HF : 2 H_2SO_4) the test piece was transferred to sulphuric acid, boiled, dried, and re-weighed. The percentage loss in weight was a measure of the attack on the block, the lowest values being obtained for good blocks.

2. The ground weighed specimen was treated with the acid mixture as in 1, the boiling with sulphuric acid was omitted, and the test piece was ignited strongly in a crucible.

The lecturer suggested that a combination of methods 1 and 2 would probably yield the most satisfactory agreement between test and works practice, and such a modified method would be tried.

The results obtained in some of his tests were closely parallel to the behaviour of the blocks tested when used in the glass tank.

The Study of a Fundamental Reaction in Glass Making. By J. T. Howarth, M.Sc., and Prof. W. E. S. Turner.

The reaction between silica and sodium carbonate was studied in two ways, namely, 1, by determining the decomposition pressures over a range of temperature up to about 800° C.; 2, by time-temperature experiments in open crucibles. A special apparatus of fused quartz was designed for the decomposition pressure determinations and it was used also for the measurement of the dissociation pressure of sodium carbonate up to 1,000°. At this temperature the dissociation pressure was 20 m.m.

Mixtures of pure quartz ground to 100-150 mesh and sodium carbonates (200 mesh) were made in the molecular proportions Na_2CO_3 4 SiO_2 ! $NaCO_3$ SiO_2 ; Na_2CO_3 ½ SiO_2. There was indication of reaction in such mixtures at temperatures approximately 270° to 850°. In the detailed study of the

mixture Na_2CO_3 4 SiO_2 it was found that the reaction could be made to proceed to completion, in a few hours at 700° in about 330 hours at 600° and in several weeks at 500°. The nature of the compounds formed appeared to depend on the temperature of reaction.

MINERALOGICAL SOCIETY.

The following papers were read at the meeting held on March 20, Dr. G. T. Prior, F.R.S., President, in the chair :—

On the Atomic Volume Relations in Certain Isomorphous Series. II. By A. F. HALLIMOND.

The volume relations of compounds of Ca, Sr, Ba, with O, S, Se, Te correspond in every way with those previously indicated for K, Ro, Cs, Na, Li, and the halogens. The difference in the volume produced by the interchange of eutropic elements exhibit a constant ratio in each series. The partial volumes calculated for the radicles from the volumes of the free metals agree with those already obtained for the alkali compounds, and the values 6 for oxygen and fluorine agree with those calculated by Wasastjerna from the refractive indices. The volume effect of substitution in the sodium chloride lattice varies somewhat with the size of the cell, but the variation never attains the extent required for a law of constant radii. Other isomorphous series agree with the Law of Retgers, and the present results are therefore expressed in terms of a law of additive volumes rather than additive radii.

On the Age and Composition of the Whin Sill and the Related Dikes of the North of England. By PROF. A. HOLMES AND DR. H. F. HARWOOD.

The rocks of the Whin Sill and its associated dikes are quartz-dolerites. Chemical analyses show that they are all of substantially identical composition. Dikes of this series run north of east. They are quite distinct from the system of tholeiite dikes to which the Bingfield dike, the Brunton type of Teall, belongs. A pebble of quartz-dolerite in the Upper Brockram of George Gill, Brackenbei Moor, near Appleby, has been proved by chemical analysis to be definitely of the Whin Sill type. This, with other evidence indicates that the age of Whin Sill and its associated dikes is post-Westphalian and pre-upper Brockram.

The Identification of Dumortierite in Grains Dumortierite in Cornish Granite. By A. W. GROVES.

Attention is drawn to the possibility of confusing dumortierite with a number of more common minerals. Dumortierite is recorded in several sediments in Southern England and in the Land's End granite.

On Bauxite from Kashmir, India. By DR. T. V. M. RAO.

The so-called bauxite of Kashmir is found to consist mainly of diaspore and an opaque mineral corresponding in composition to a monohydrate of alumina. The deposit was derived from beds of clay, having been first altered into the di-hydrate (bauxite) and subsequently to its present condition through dehydration and thermodynamic metamorphism.

GEOLOGICAL SOCIETY OF LONDON.

The following communication was read at the meeting held on March 7 :—

The Major Intrusions of South-Eastern Iceland. By HILDA KATHLEEN CARGILL, M.Sc., F.G.S., LEONARD HAWKES, D.Sc., F.G.S., AND JULIA AUGUSTA LEDEBOER, M.Sc., F.G.S.

The main plutonic intrusions into the Tertiary plateau-basalts of Iceland were discovered some forty-five years ago in the south-east of the island, but little is known of their field-relations or petrology—and the present paper is a summary of the results obtained in the course of several summer visits to the more accessible localities.

The outcrops are scattered; the largest one (the Slaufrudal Stock) is elongate in plan, and its area covers $1\frac{1}{4} \times 4\frac{3}{4}$ miles. The relationship of intrusives to country-rocks (splendidly exhibited in a series of cliff- and deep valley-sections) is a discordant one, the intrusions being stocks with steep-sided walls and domed roofs (not laccoliths as formerly suggested). The elongation of the stocks is parallel to the strike of the regional dykes, and insrusion clearly took place under, and was facilitated by, crustal tension. All intrusions are multiple : the common association is that of gabbro and granophyre. A horizontal layered structure of granite and granophyre is visible in the Slaufrudal stock, which seems to have grown by the injection of successive sills with intermittent subsidence of the replaced block.

The rocks belong to the calc-alkaline suite, and comprise in the order of differentiation gabbro-peridotite, gabbro, diorite, granodiorite, granophyre, granite, quartz-vein. This sequence may be correlated with the order of crystallisation, which in the

colourless minerals is :—plagioclase, potash felspar, potash felspar and quartz, quartz. No true orthoclase has been detected in the rocks—the 'potash felspars' are shown by analysis to contain about 40 per cent. of orthoclase. The plagioclase of the most basic rocks (gabbro-peridotites), which are poor in felspar, is more acid than that of the less basic and felspar-rich gabbros.

Eight new analyses are given. The suite, with the addition of granodiorite, is similar to that of the main plutonic intrusions of Tertiary age in Scotland. Comment is made on the absence of alkaline types in a region of 'Atlantic' tectonics.

The acid rocks exhibit two extreme textures—the graphic and the granitic, with intermediate varieties (semi-granophyres). The granophyres are richer in plagioclase and poorer in quartz than the granites which are quartz and potash-felspar rocks with 1 to 5 per cent. of hornblende. In the semi-granophyres the last residuum to crystallise shows granitic texture, and this is correlated with the fact that the granites are a later differentiate than the granophyres. The failure of the graphic intergrowth is ascribed to a diminished magmatic viscosity due to an increased content of volatile substances, with a consequent wider spacing of the centres of spontaneous crystallisation, which inhibits the formation of the graphic fret.

The composition of the fret approximates to Vogt's 'granite eutectics,' and the granophyres are considered to be eutectics, the excess of quartz in the granite residues being due to the presence of water.

In the whole Icelandic area intermediate risks are relatively unimportant in bulk, the extrusives are dominantly basic, and the intrusives dominantly acid : this may be related to the superior mobility of the basic magma.

The absence of a sedimentary 'floor' in Iceland is noted, and in harmony with J. Barrell's hypothesis that the collapse of the North Atlantic basaltic plateau resulted from the intrusion of a basic magma, it is suggested that the preservation of the Iceland-Faeroes remnant is due to the intrusion beneath it of an acid magma.

Discussion.

The President referred to the interest of Iceland as a continuation of the volcanic area of North-Western Scotland. He congratulated the Authors on the beauty of their photographs, which enabled them to demonstrate so clearly the contrast between the laccolithic and the stock-intrusions. The Authors' conclusions were supported by the observations of Dr. G. W. Tyrrell on the gabbro intrusion of Midhyrna on the Snaefels peninsula, as it had the same steep-sided margin. The absence from Iceland of any pre-volcanic rocks indicates that it has undergone great subsidence; and he thought that, instead of the Icelandic-Faeroes ridge, the former land-extensions were part of a continental area, the foundering of which beneath the Atlantic and the Arctic Oceans was the cause of the volcanic eruptions and the intrusions.

He was glad to find that the Authors supported the view that the rocks of the Iceland area do not afford evidence of the connection of an alkaline rock-type with an 'Atlantic' tectonic structure.

Dr. H. H. Thomas congratulated the Authors on what was a most valuable contribution to our knowledge of Tertiary vulcanicity, and on being able to bring before the Society an account of the very imperfectly known Icelandic plutonic rocks. He thought that the illustrations of stock-intrusion were the most convincing and most beautifully displayed that had ever been described. The Authors had definitely proved in the case of the Slaufrudal stock that subsidence was the controlling factor of intrusion, and the process of repeated intrusion was identical with that which had operated in the ring-dykes of the Tertiary centres of

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ROYAL SOCIETY OF ARTS.

Competition of Industrial Designs, 1928.

By kind permission of the Board of Governors of the Imperial Institute, the public exhibition of works sent in for this year's Competition of Industrial Designs will be held in the Exhibition Pavilion of the Imperial Institute, South Kensington, S.W. Full particulars of the Scholarships and prizes offered in connection with the Competition can be obtained from the Secretary of the Royal Society of Arts, Adelphi, W.C.2. Applications for forms of entry, labels, and instructions must be sent to the Secretary of the Society between May 1 and May 12. The designs entered for the Competition are to be forwarded to the Imperial College of Science and Technology, Imperial Institute Road, South Kensington, S.W., between June 18 and June 20, and after the Judging, which takes place in July, the accepted designs will be on view at the Imperial Institute from August 4 to September 1 (Sundays included).

NOTICES OF BOOKS.

Radiation in Chemistry. By ALAN MORTON, B.Sc., Ph.D. (Lon.), F.I.C. Lecturer in Chemistry in the University of Liverpool. Pp. X + 284. Price 15s. net. London: Baillière, Tindall and Cox, 8, Henrietta Street, London, W.C.2.

The never-ending progress of Chemsitry calls for a continuous flow of books, so that authentic details of the latest advancement may be available in compact form. It is very desirable that the subject should be dealt with by competent authors from the practical viewpoint, and no one could deny the competency with which Mr. Alan Morton has dealt with the interesting subject of Radiation in Chemistry. We notice, by the way, that a large portion of one chapter is devoted to the anti-glare glasses of Sir William Crookes. It is, we think, a good arrangement to give the bibloography (as in the present volume) after each chapter, rather than in bulk at the end of the work. The book is valuable, giving a good deal of up-to-date information, with defiuite references which will enable those that desire more detailed information to have recourse to the appropriate works on the different phases of the subject.

FORTHCOMING EVENTS

ROYAL MICROSCOPICAL SOCIETY.

20, Hanover Square, London, W.1.

Wednesday, April 18, at 7.30 p.m.—Dr. K. F. Belar (Kaiser-Wilhelm Institute for Biology, Berlin): "The Separation of Proto plasm in the *Myxomycete Didymium* by Stimuli." Mr. B. R. ohnson :" Some Introductory Experiments dealing with a *Quantitative Method of Determining* the Resolving Power of Microscope Objectives."

ROYAL SOCIETY OF ARTS.

Monday, April 16, at 8 p.m.—(Dr. Mann Lecture). A. G. Huntley, of the May Construction Co., Ltd.: "Applied Architectural Accoustics." (Lecture I.)

Wednesday, April 18, at 8 p.m.—(Ordinary Meeting). Alfred C. Bossom, F.R.I.B.A.: "American Architecture." Professor A. E. Richardson, F.R.I.B.A., will preside.

SOCIETY OF GLASS TECHNOLOGY.

Tuesday, April 17, at 7.30 p.m.—In the General Lecture Theatre, The University, Western Bank, Sheffield.—" Stained Glass and the Renaissance Period."

Wednesday, April 18, at 3 p.m.—In Room C4, Applied Science Department, The University, Sheffield.— "Some New Facts Arising from a Study of the Casing of *Colourless* by *Coloured Glass.*" By S. English, D.Sc., F.I.C., Prof. W. E. S. Turner, and F. Winks, M.Sc.Tech.

"The Control and Distribution of Temperature in Lehrs." By A. Cousen, M.Sc., H. W. Howes, M.Sc.Tech., and F. Winks, M.Sc.Tech.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

8,252.—Bridger, C. J.—Production of ethyl alcohol. March 19th.

8,544.—Davis, W. G.—Manufacture of higher alcohols. March 21st.

8,304.—Edmonds, F.—Chemical closets. March 19th.

8,548.—Imperial Chemical Industries, Ltd. — Recovery of methanol. March 21st.

8,287.—I. G. Farbenindustrie Akt.-Ges.—Production of high-valent etherified alcohols, etc. March 19th.

Specifications Published.

277,285.—Newport Co.— 3, 4 diamino benzoyl o-benzoic acids and a process of making the same.

287,281.—Vidal, A. E. (Riedel Akt.-Ges., J. D.),—Manufacture of hydrogen peroxide.

287,401.—Fairweather, H. G. C. (Seldon Co.).—Preparation of vanadic acid.

284,208.—Soc. Generale Metallurgique De Hoboken. — Manufacture of sulphuric acid.

267,164.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of ortho-aminocarboxylic acids of the anthraquinone series and substitution products thereof.

Abstract Published.

284,588.—Acetic acid.—I. G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany.

Acetic acid; acids, concentrating.—In concentrating acetic acid solutions by adding a solvent which lowers the boiling-point of water, and then distilling fractionally, an acetic acid alkyl ester, such as ethyl acetate, is employed as the solvent. In an example, equal parts of acetic acid of 40 per cent. and ethyl acetate are mixed and distilled. Water and ester distil off at 69-70° C., and the condensate separates into two layers, the ester being returned to the still. When the temperature rises to 77° C., the operation is finished, pure acetic acid remaining in the still. It is stated that xylene and acetone oils have been used previously.

The Latest TRADE MARKS

This list of Trade *Marks of interest to* Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

SLENDEX.

488,602.—Chemical substances prepared for use in medicine and pharmacy.—The National Chemical Holdings, Limited, Appleby House, 46, St. James's Place, London, S.W.1. *March 28th.*

MONZOL.

488,565.—All goods in class 3 which includes chemical substances prepared for use in medicine and pharmacy.—The Mond Staffordshire Refining Company, Limited, 47, Victoria Street, London, S.W.1. March 28th.

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CONTENTS. PAGE.

Scientific Method of Training in Schools and Colleges ... 241
By Robert Saxon, B.Sc., F.C.S., Member of the American Chemical Society.
Some Physico Chemical Properties of Stannous Chloride ... 243
By Colin G. Fink & C. L. Mantel.
Condensation of Nitriles with Thio-acids ... 245
By Seiichi Ihikawa.
General Notes ... 248
Proceedings & Notices of Societies:—
The Royal Society ... 251
The Royal Society of Arts ... 253
The Chemical Society of Japan ... 253
Correspondence.—An Instance of Multiplication by Proportion ... 254
By A. Sakoschansky, B.Sc.
Reviews of Books ... 254
New Patents and Trade Marks ... 255

SCIENTIFIC METHOD TRAINING IN SCHOOLS AND COLLEGES.

By ROBERT SAXON, B.Sc., F.C.S., Member of the American Chemical Society.

Post-primary training of the constructive faculty, and the analytic deductiveness, as applied to research does not make that progress one would expect in this so called scientific age. In a good number of schools it is non-existent, partly owing to the cost of fitting up laboratories, their upkeep, and mostly to the lack of inventiveness and love of research on the part of the teacher. This so called science which is placed upon the time-table is generally looked upon by the pupil as a series of trick lessons wherein magic plays a great part, spectacular phenomena alone interest, and the innate love of discovery chilled by research of which the importance is never made manifest. Science is never made a hobby. It is always a task. Numberless observations are insisted upon so that it may be discovered who may be fortunate enough to see the correct reading and get the nearest average.

Handicraft, cookery, art, needlework, music, dancing, poetry, all are of strong appeal. All are put in the loving care of expert nurses who make their charges as lovable as devotion is able. Yet science that seeks to unfold the mysteries of everything around and within us, that seasons desire to know the why and wherefore of all that we touch, see, feel, or imagine, is left in the hands of people who never seek any new way to make discovery a delight, or invest ordinary reactions in everyday life with the charm of far-reaching deduction, and fostering a hunger for further research.

The person responsible for the spread of science should be a lover of science, a dabbler in science, one who will get pupils to gather round to see what it is in this wonderful world in which he gets so much delight that makes him so fascinating and at the same time easy and companionable a wizard to follow. To be this one thing only is needed. Science must be a devotion, and it must also be a master well understood fundamentally, in order that disciples may be made by the lucid reasonableness of all its demands. "Seek and ye shall find; knock and it shall be opened unto you."

All the great men of research have designed or made their own apparatus, and science training is no sort of training unless it develop power of thinking in the third dimension. Solid Geometry caters for this. On the other hand the mind which cannot appreciate elevation and its significance has constant recourse to pathetic attempts at perspective, without much regard to the laws of that art. The vast majority of attempts to illustrate apparatus by perspective painfully offend the eyes of anyone at all conversant with the principles of model drawing. Plane projections are all that is necessary, and as most apparatus is circular in section, there is no necessity for plans. Elliptical representations of circular tops of vessels are often accompanied by straight line bases making the whole thing grotesque. The drawing of the lipped turned-over edge of a beaker would tax the powers of a skilled draughtsman, yet it is attempted by most indifferent illustrators in text-books, and moreover a front elevation is easy to draw, easy to understand, and sufficiently expressive to anyone who has seen a beaker. This appreciation of the third dimension is given to most boys, but is allowed to die of neglect. Its demise may be placed at about the sixteenth year.

After that a teacher of applied solid geometry has the utmost difficulty in getting students to understand working drawings of engine and machine details, if those pupils are men, yet youths of 13, 14, or 15 years of age have little or no difficulty in letting their concepts come out of the plane of the paper. They have the constructive imagination as yet alive. This edificatory talent neglected by attempting to draw everything as a picture instead of a projection on a vertical plane dies, and with it the power of conceiving structures before they are reared. Lattice diagrams, crystal structure, crystalline possibilities in section, the tetrahedron function of carbon's valency, mass spectrography and the ultra-violet rays on crystals, are definitely, and in relative quantities, shown by projections, as well as lending themselves to mathematical analysis. The mind which is going to lucidly understand and lucidly interpret crystal and molecular structure, must be one that can clearly realise its world of conception absolutely independent of the paper upon which the representation is attempted. The whirling units must revolve and rotate without interfering with, in harmony with others of like motions in the same "ecliptic" and also in "ecliptics" parallel to theirs, or at definite angles with theirs like those of the moon and the earth, and whose lines of intersection are so disposed towards one another angularly as to make definite systems of crystals possible. These rotatory systems must "gear" properly with one another, with possibly electrons or electronoids corresponding to spur-wheel teeth. Such cannot be either illustrated or conceived clearly without "solid" thinking. Elevation, plan, section, development, interpenetration, spherical trigonometry, must all be grasped and represented. Magazine-cover fiery nebulæ "impressions" are as plausible as some illustrations of atomic cinematics. It is a fact that crystals such as mica cleave easily in parallel planes to a degree of thinness as great as desired, and imagination carries on the splitting until the impossible plane is obtained having no thickness, but that does not prove that atomic universes have only two dimensions, for that would dispose of weight, unless gravity ceases to have effect at absolute planity as at absolute zero, as the volume decreases regularly in arithmetical progression with decreasing temperature. This planar concept, however, does not explain the force necessary to cleave crystals, the existence of a number of intersecting planes of cleavage, nor the constitution of amorphous, liquid, solute, solvent, colloid sol, and colloid gel. It may be that in crystallisation chaos may give way to the influence of major centres of attraction and the establishment of planar whirls by the passing on from centre to centre of circumambient ions, which move as ring dancers do swinging from hand to hand. No other concept serves to explain the crystallation of old obsidian, lava, glass, or sugar from solid homogeneous masses to granite with its mica or sugar with its facets glistening in the sun. This exchange of ions or electrons will mean a change of character, and obsidian becomes nepheline, sodium, potassium, and aluminium, being created by this passing on of electrons, at the expense or otherwise of the quartz matrix which binds the lot. Afterwards carbonic acid comes along, and being of greater negative charge than silica, and also being able to furnish solutes, displaces that acid oxide and the carbonates of soda and potash result. That of alumia is not a solute and does not result but remains with the silica as silicate clay, chaos resuming, and crystalline regularity giving way to amorphous mass. The word crystal has reference to silica for being very hard the ancients thought it to be water frozen so hard that no power could melt it. Incrustation often crystalline contains the common root meaning hard and makes these words cognate with cruel, crudelis, crudus, cruditas, in Latin, and raw, and crust, in English.

Regarding the *indestructibility of matter*, it should be made clear that this is only true as far as our knowledge goes. Granite, even in spite of its adamantine hardness, is broken down by such mild members of creation as carbon dioxide and water. What appears so imperishably permanent is slowly passing to plastic clay. To reason by analogy, seeing that nothing is permanent, we should say that in all probability not only do compounds of complex structure give way to others more simple, but elements undergo change, and that new ones are born every age. Stars there are composed of hydrogen, carbon, calcium, etc., only, and it is well within the range of possibility that in ages they become as mixed in composition as the earth. There are parallels everywhere. Plants live on simple compounds like carbon dioxide, water, and salts. They produce cellulose in some form or other, and highly organised compounds like legumen. Man takes these highly complex compounds and produces simple ones like water and carbon dioxide. If it is thus throughout the universe why

should the atom be exempt from change? The vast majority of chemistry teachers are too fond of oracular certitude. Instead of saying that a gas is as dry as sulphuric acid, calcium chloride, or phosphorus pentoxide can make it, they say that the gas is dry. The student ought to see in his mind water making its way from the gas to the drying agent, continuously. He ought to see that he can take it away from the dessicator too soon, and that a point is reached finally where no more water will pass in one direction without an equal amount passing in the other. This passing should be compared with others as the loss of heat by radiation from a calorimeter. The student should understand that he is dealing with something which is passing in both directions in and out of the calorimeter at the same time. He should not be under the impression that all the heat lost by the body under test goes to the water and metal or glass cover. The first thing a novitiate acrobat learns with every new trick is how to fall or fall with minimum injury or danger. A beginner in chemistry or physics must likewise be shown how to make corrections for faulty apparatus. He should stage these deviations from truth and observe them so as to be able to say how far they go in the time which is necessary to work the experiment. Thus with the calorimeter he may try to plot the loss of heat in a given time, and thereby see how much he will lose during his experiment. He will then learn whereabouts between 100 degrees and zero he loses most heat and profit by his trial.

(To be continued.)

Obituary.

PROFESSOR JOHN S. McARDLE.

Professor Dr. John Stephen McArdle, Professor of Surgery at University College, Dublin, died on April 14. He was born in Dundalk in 1859, and was consequently 69 years of age.

MR. EDWARD ARMSTRONG, F.B.A.

The above gentleman died at Oxford on April 14, at the age of 82 years. He was formerly Pro-Provost at Queen's College, Oxford, and a well-known historian, who specialised in the history of the Italian Renaissance.

SOME PHYSICO CHEMICAL PROPERTIES OF STANNOUS CHLORIDE.

By Colin G. Fink and C. L. Mantell.

Preparation of Pure Stannous Oxide.

Various experimenters have failed in attempting to get pure stannous oxide, using stannous chloride as a source, treating with soda, forming the hydroxide, heating, filtering and washing. Oxidation or hydration took place during these procedures so that stannic oxide was formed.

Ditte (*Pogg. Ann.*, 1882, XXVII, 145) gives the following method which is satisfactory for the preparation of pure stannous oxide. Stannous chloride is dissolved in water and treated while hot with the smallest amount of concentrated hydrochloric acid to clear the solution. Stannous hydroxide is then precipitated by the addition of a soda solution (*e.g.*, a carbonate) which is added in small amounts until the mixture is just alkaline to phenolphthalein but not to litmus. The milkwhite solution is then kept at 110° C. for several hours. The white material changes to blue-black, stannous oxide, with its characteristic metallic sheen. It is washed by decantation and dried.

Following Ditte, stannons oxide was prepared from stannous chloride crystals. Strict adherence to his directions as to control of alkalinity is the important factor in the production of pure SnO. Solutions too highly alkaline (greater than pH7) cannot be made to yield stannous oxide even after several hours' boiling. Within the range of pH5 to pH 6.5, stannous oxide is readily produced. Our material corresponded exactly to SnO shown for Sn by iodine titration.

SnO boiled in distilled water for half an hour did not produce any stannous hydroxide or metastannic acid. It did not change in colour, appearance, or crystalline form, in any manner observable under the microscope.

It would, therefore, seem that the reaction :

$$Sn(OH)_2 = SnO + H_2O$$

is not readily reversible. The thermal data

$$Sn(OH)_2 = SnO + H_2O - 1910 \text{ calories}$$

show it to be endothermic.

Thermal Decomposition of Stannous Oxide.

The physico-chemical properties of stannous oxide explain the manner in which stannic oxide is reduced by gas. The reduction may be assumed to take place in either of two ways. The stannic oxide may either be reduced directly to tin or it may be first reduced to stannous oxide which may be further reduced to tin.

The literature records observations that stannous oxide is unstable above certain temperatures and therefore does not exist above this point. Above the thermal decomposition point of stannous oxide, the reduction of stannic oxide results in the direct production of tin, below this point, stannous oxide may be produced. No easy chemical method exists for the separation of tin and stannous oxide because of their solubilities in the same reagents. It was thought that the qualitative detection of decomposition could be made by the observation of the formation of white stannic oxide. The reaction is assumed to be :

$$SnO + SnO = SnO_2 + Sn$$

But it is not possible, except with most exacting care of details, to maintain an inert gas atmosphere with complete absence of oxygen or moisture. Both oxygen and moisture react with stannous oxide to form the stannic oxide. If, however, the stannic oxide formation is disregarded and only the formation of metallic tin is used as a criterion of thermal decomposition, we have a reliable method for detection of the phenomenon.

The change from crystalline stannous oxide to metallic tin is easily recognised microscopically.

Ditte found that at high temperatures SnO is unstable and decomposed according to the reaction :

$$2\,SnO = SnO_2 + Sn$$

Fraenkel and Snipischsky (*Z. anorg. Chem.*, 1922, cxxv, 235), confirmed this and found that stannous oxide was unstable above 500° C.

Our work shows that the above observations were correct but that the reaction takes place at lower temperatures. Stannous oxide is thermally decomposable above 385-390° C. and is thermally stable below this point.

The reaction $SnO_2 + H_2$ can therefore not be assumed to be a two-step process of reduction above this temperature. Above 385° C. we then have

$$SnO_2 + 2H_2 = Sn + 2H_2O$$

Below the thermal decomposition point of SnO, the reduction of stannic oide by hydrogen takes place in two stages :

$$SnO_2 + H_2 = SnO + H_2O$$
$$SnO + H_2 = Sn + H_2O$$

each of which can be observed. The temperature at which reduction takes place can be regulated so as to allow the formation of SnO. We have proved this by experiment.

The Oxidation of Stannous Oxide.

Compressed air was used as oxidising material. It entered the silica furnace tube, heated by an electrical resistance furnace. The furnace was first brought up to the desired temperature, then opened, the boat of stannous oxide put in place and the furnace closed. The boat came to temperature very rapidly and the surface of the charge almost immediately. The boat and charge were removed, cooled in a desiccator and examined.

The criterion of oxidation was the formation of stannic oxide.

Above 235° C. stannous oxide is instantaneously oxidisable in moist air. It burns like tinder and is almost pyrophoric in its action.

Three runs were made, at 225° C., 230° C., and 235° C. over measured time intervals to determine whether the stannous oxide was affected over an appreciable time interval. These show that at 225° C., stannous oxide is not affected by moist air after a ten minute period. It is therefore, concluded that from 225° C. to 235° C. stannous oxide is oxidised at a slower rate than above 235° C. Below 225° C. it is not readily oxidised by moist air.

Duplicate determinations were made at the same temperatures, substituting dried air for the moist air. The air supply was the same as in the experiments but the air was cleaned and dried by bubbling through sulphuric acid, a tower packed with glass wool and absorbent cotton in alternate layers, and two soda lime towers in series. The results were quite analogous to those of moist air. Dry air effected oxidation at temperatures as low as 220° C. but not as low as 210° C.

It is concluded that above 240° C., stannous oxide is readily changed to stannic oxide by both dry and moist air. At this and higher temperatures stannous oxide has pyrophoric tendencies, which increase with rise of temperature.

Oxidation of Stannous Oxide by Sulphur Dioxide in Solution.

In the course of some work on the leaching of tin ores, sulphur dioxide in saturated solution was used as an aid in experimental leaching as an addition to other materials being used. Paralleling these experiments stannous oxide was leached with the same solutions. Often the black stannous oxide was changer to a white or cream coloured precipitate having the physical appearance and chemical characteristics of metastannic

acid or stannic oxide. This would be in accordance with the reaction :

$$2\ SnO + SO_2 = 2\ SnO_2 + S \quad \text{or}$$
$$2\ SnO + SO_2 + 2\ H_2O = 2\ H_2SnO_3 + S$$

In other cases tin in finely divided form resulted from the action of SO_2 on stannous oxide :

$$SnO + SO_2 + H_2O = Sn + H_2So_4$$

CONCLUSIONS.

Stannous oxide can be readily prepared in a state of high purity if due precautions are taken to have proper pH conditions.

It is thermally unstable above 385° C., giving Sn and SnO_2.

Stannous oxide is readily oxidised by both moist and dry air above 240° C. At higher temperatures it is pyrophoric.

Stannous oxide is oxidised by sulphur dioxide in acid solutions and reduced by the same reagent in alkaline solutions.

The reduction of stannic oxide, reasoning from the data on stannous oxide, is a single step reaction above 385° C., and a two step reaction below that temperature.

(Abstracted from *The Journal of Physical Chemistry*, 1928, xxxii, 103-112).

CONDENSATION OF NITRILES WITH THIOACIDS. PART I.

By SEIICHI ISIKAWA.

(*Institute of Physical and Chemical Research, Tokyo.*)

The well-known reaction of Pinner which occurs between nitriles and alcohols under the action of hydrogen chloride, is generally believed to take place in such a way that imino-chlorides which are formed from nitriles as the intermediate substances, react with hydroxyl groups of alcohols through the medium of their chlorine-atoms, giving imino-ethers as final products, as is seen in the following equation :

$$\underset{\overset{\|}{NH}}{R.C}-Cl + HO.R' = \underset{\overset{\|}{NH.HCl}}{R.C}-O-R' \qquad (1)$$

Since, if mercaptans are used in place of alcohols, thioethers are formed, the mechanism of the condensation in these cases must be regarded as the same as that of the above reaction, thus :

$$\underset{\overset{\|}{NH}}{R.C}-Cl + HS.R' = \underset{\overset{\|}{NH,HCl}}{R.C}-S-R' \qquad (2)$$

As a matter of course, therefore, it is concluded that compounds which contain alcoholic hydroxyl or sulphhydryl group in their molecules have a capacity to condense with nitriles under the influence of hydrogen chloride.

Furthermore, according to the previous experiments of the present author, thiamides or thionanilides seem to act upon nitriles under the same conditions as the above in such a way that thiamides or thioanilides are transformed at first into iso-form and then condense with nitriles by means of sulphhydryl group thus formed, giving imino-sulphides as intermediate products, thus :

$$\underset{\overset{\|}{NH}}{R.C}-Cl + HS-\underset{\overset{\|}{NH}}{C}.R' = \underset{\overset{\|}{NH}}{R.C}-S-\underset{\overset{\|}{NH}}{C}.R' + HCl \qquad (3)$$

Now, since thiamides or thioanilides in their iso-form behave as acids rather than as bases, it is inferable that nitriles may enter into condensation also with compounds which contain acidic sulphhydryl group in their molecules. If this supposion is correct, thioacids should be able to condense with nitriles, because they have acidic sulphhydryl group in their molecules.

At the suggegstion of this consideration, benzonitrile and thioacetic acid were taken in equimolecular proportion, and allowed to react with each other in dry ether which was saturated with hydrogen chloride, whereupon, although a condensation-product of both compounds used was not detected, yet thiobenzamide and benzimino-isothiobenzamide were obtained as reaction-products. (Exp. I). In this case, since there is no other way conceivable except that the chlorine atom of the benziminochloride interacts with the sulphhydryl group of the thioacetic acid, a product of the first stage of this reaction must be acetylbenzimiosulphide, and the formation of thiobenzamide may be considered to be due to the decomposition of this intermediate compound by the action of hydrogen chloride, as is seen in the following representations :

$$C_6H_5-\underset{\overset{\|}{NH}}{C}-Cl + HS-\underset{\overset{\|}{O}}{C}.CH_3 = C_6H_5.\underset{\overset{\|}{NH}}{C}-S-\underset{\overset{\|}{O}}{C}.CH_3 + HCl,$$

$$C_6H_5.\underset{\overset{\|}{NH}}{C}-S-\underset{\overset{\|}{O}}{C}.CH_3 + HCl = C_6H_5.\underset{\overset{\|}{NH}}{C}-SH + Cl-\underset{\overset{\|}{O}}{C}.CH_3 \qquad (4)$$

By the same treatment as the above, p- and m-nitrobenzonitrile were easily converted into p- and m-nitrothiobenzamide respectively (*Exp. II and III*). *This method* may be applied to the preparation of nitro-derivatives of thiamides which are apt to be *reduced even in Albert's synthesis which is regarded as an improvement on the method of Gabriel and Heymann.*

The reaction between benzonitrile and thiobenzoic acid was found to take place according *to the same mechanism as in the* case of the Experiment I just mentioned, resulting in the formation of thio-benzamide, benzoyl chloride and benzimino-isothiobenzamide (Exp. IV). *It is needless to say* that the benzimino-isothiobenzamide which was isolated in the Experiment I and II. is a secondary reaction-product formed from benzonitrile and thiobenzamide which is the primary reaction-product.

Since hydrogen sulphide has the sulphhydryl group and chemical proerties analogous to those of thioacids, it is expected that under the same condition the former will condense with nitriles as the latter, as is represented in the follolwing equation :

$$C_6H_5.\underset{\overset{\|}{NH}}{C}-Cl + HSH = C_6H_5.\underset{\overset{\|}{NH}}{C}-SH + HCl \qquad (5)$$

To test the correctness of this idea, an ethereal solution of benzo-nitrile was saturated at first with hydrogen chloride and then with hydrogen sulphide under cooling with a freezing mixture, whereupon, only benzimino-isothiobenzamide was obtained in a very pure state as a reaction-product, and therefore the reaction appeared as if it had occurred according to the mechanism represented by the following scheme :

$$C_6H_5.\underset{\overset{\|}{N}}{C}-Cl + HSH + Cl-\underset{\overset{\|}{NH}}{C}.C_6H_5 \longrightarrow C_6H_5.\underset{\overset{\|}{NH}}{C}-S-\underset{\overset{\|}{NH}}{C}.C_6H_5$$

$$\longrightarrow C_6H_5.\underset{\overset{\|}{NH}}{C}-N = \underset{\overset{|}{SH}}{C}.C_6H_5 \qquad (6)$$

To make sure of the mechanism of this *reaction, p-tolunitrile and β-naphthonitrile* were selected in place of benzonitriles (Exp. VI and VII), because the two nitriles have a great tendency to combine with hydrogen *sulphide into thiamides in the Gabriel and* Heymann synthesis, and a weak affinity to condense with thiamides into amino-isothiamides. The results of the experiments have shown that both nitriles are converted into p- thiotoluamide and γ-thionaphthamide respectively, together with a formation of a minute amount of red condensation-products. *In the case of the Experiment V*, therefore, it is most probable that thiobenzamide was at first formed according to the Equation (5), and it condensed into benzimino-isothiobenzamide as soon as it formed, owing to the presence of an excess of benzonitrile unchanged.

Moreover, experiments were undertaken in expectation that, if metallic sulphides, such as potassium sulphide, calcium sulphide and zinc sulphide, are used in place of hydrogen sulphide, the reactions will take place in the way represented by the Equation (6). It was only confirmed, however, in each case that the formation of thiamides is always the primary course of the reaction of this kind.

From the above experimental results, it is *concluded that Pinner's reaction takes place* not only between nitriles and compounds containing alcoholic hydroxyl or sulphhydryl group in their molecules, but also *between nitriles and compounds having* acidic sulphhydryl group in their molecules.

Experimental.

I. Benzonitrile with Thioacetic Acid.

5.1 Grams of benzonitrile and 3.8 g. of thioacetic acid (molecular proportion) were dissolved together in 50 c.c. of absolute ether, and this solution, kept cool with a freezing mixture, was saturated with dry hydrogen chloride, whereupon the colour of the solution began to change gradually into reddish-orange, but no deposition of crystals was observed even after a day. By evaporating ether off from the solution in diminished pressure at room temperature, a red resinous substance having a strong odour of thioacetic acid was left as a residue. This residue was treated with a solution of sodium bicarbonate, washed with water, and then filtered. About 4.8 g. of thiobenzamide and 1.0 g. of benzimino-isothiobenzamide were isolated from the residue obtained, and a large amount of acetic acid was detected in the filtrate.

II. p-Nitrobenzonitrile with Thioacetic Acid.

A mixture of 5 g. of p-nitrobenzonitrile and 2.7 g. of thioacetic acid (molecular proportion) was brought in 150 c.c. of absolute ether. Although about one-third of the amount of p-nitrobenzonitrile was left undissolved, the treatment was carried out as usual, whereupon about 2 g. of p-nitrothiobenzamide together with a minute amount of a red condensation-product was produced.

After repeated recrystallisation from hot water and then from boiling benzene, p-nitrothiobenzamide was obtained in yellow prismatic crystals. It was found to melt at 157° to a red liquid which solidified to the original yellow mass on cooling. The analysis of it gave the following value for nitrogen and sulphur.

(1) 9.87 Milligrams of the sample evolved 1.285 c.c. of nitrogen at 18.8° and 760 mm.

(2) 56.1 Milligrams of the sample gave 76.1 mg. of Ag_2S.

	Found	Calc. $C_7H_6N_2SO_2$
N	15.23	15.38 per cent.
S	17.56	17.58 per cent.

III. m-Nitrobenzonitrile with Thioacetic Acid.

3 Grams of m-nitrobenzonitrile and 1.7 g. of thioacetic acid (nearly molecular proportion) were dissolved together in 150 c.c. of absolute ether, and treated as usual, whereupon about 0.5 g. of m-nitrothiobenzamide together with a minute amount of a red condensation-product was formed.

m-Nitrothiobenzamide was crystallised from boiling benzene, from which it separated in yellow plates, which melted at 130-131° to an orange-yellow liquid. The analysis of it gave the following results :—

(1) 12.07 Milligrams of the sample evolved 1.555 c.c. of nitrogen at 18.2° and 760 mm.

(2) 90.7 Milligrams of the sample gave 123.0 mg. of Ag_2SO_2.

	Found	Calc. $C_7H_6N_2SO_2$
N	15.19	15.38 per cent.
S	17.54	17.58 per cent.

IV. Benzonitrile with Thiobenzoic Acid.

5.2 Grams of benzonitrile and 6.9 g. of thiobenzoic acid (molecular proportion) were dissolved together in 50 c.c. of absolute ether, and this solution was treated as usual. About 6.5 g. of thiobenzamide, about 0.5 g. of benzoyl disulphide and a minute amount of benzimino-isothiobenzamide were obtained as reactionlproducts. The presence of benzoyl chloride in the reaction-mixture was also confirmed.

V. Benzonitrile with Hydrogen Sulphide.

50 Cubic cnetimetres of absolute ether which contained 3 g. of benzonitrile were saturated with dry hydrogen chloride, and then dry hydrogen sulphide was passed through it for 2 hours. After this treatment was over, the flask containing the solution was tightly stoppered with a cork and kept in the ice-chest, whereupon the solution became red, followed by the gradual increase of the depth of colour. After one week, the contents of the flask were examined, and about 0.1 f. of benzimino-isothiobenzamide only was found to be formed, and no trace of thiobenzamide was detected.

VI. p-Tolunitrile with Hydrogen Sulphide.

3 Grams of p-tolunitrile in 50 c.c. of absolute ether were treated as in the Experiment V just described, whereupon 0.05 of p-thiotoluamide together with a trace of a red condensation-product was found to be formed. The analysis of p-thiotoluamide was made for the sake of certainty and the result was found to be as follows :

28.9 Milligrams of the sample gave 46.9 mg. of Ag_2S.

	Found	Calc. C_8H_9NS
S	21.01	21.19 per cent.

VII. β-Napththonitrile with Hydrogen Sulphide.

3 Grams of β-naphthonitrile in 50 c.c. of absolute ether were treated with hydrogen chloride and hydrogen sulphide as usual, whereupon about 0.7 g. of β-thionaphthamide together with a minute amount of a red condensation-product was found to be produced. The analysis of β-thionaphthamide was made for the sake of certainty and the result was found to be as follolws :

17.8 Milligrams of the sample gave 23.8 mg. of Ag_2S.

	Found	Calc. $C_{11}H_9N_2S$
S	17.31	17.11 per cent.

VIII. Benzonitrile with Potassium Sulphide.

1. 50 Cubic centimetres of ether which contained 5 g. of benzonitrile (1 mol.) were saturated with hydrogen chloride, followed by the addition of 2.5 g. of powdered potassium sulphide (0.5 mol.)), whereupon the solution soon produced a milky turbidity and began to be coloured red after 15 minutes. On allowing the mixture to stand for 10 hours with occasional shaking a yellowish-orange coloured benzimino-isothiobenzamide hydrochloride was deposited, mixed with potassium chloride and sulphur. The yield of the free benzimino-isothiobenzamide amounted to about 0.8 g. Thiobenzamide

which was expected to be formed was not detected—not a trace of it in spite of a careful examination.

2. 3 Grams of benzonitrile (1 mol.) in 50 c.c. of absolute ether were treated with dry hydrogen chloride and 9.5 g. of potassium sulphide (3 mols.) as mentioned above, and left standing about 15 minutes, after which time no change of colour of the solution was yet observed. The reaction-mixture was then poured out from the vessel into a solution of sodium bicarbonate and examined, whereupon about 1 g. of thiobenzamide only was obtained.

IX. Benzonitrile with Calcium Sulphide.

3 Grams of benzonitrile (1 mol.) in 30 c.c. of absolute ether were treated with hydrogen chloride and 3.2 g. of powdered calcium sulphide (1.5 mols.) as in the Experiment VIII just described, whereupon 0.75 g. of thiobenzamide together with a minute amount of benzimino-isothiobenzamide was found to be formed.

X. Benzonitrile with Zinc Sulphide.

3 Grams of benzonitrile (1 mol.) in 30 c.c. of absolute ether were treated with dry hydrogen chloride and 4.5 g (1.5 mols.) of powdered zinc sulphide as usual. About 2 g. of thiobenzamide and a minute amount of benzimino-isothiobenzamide were obtained as reaction-products.

XI. Action of Hydrogen Chloride upon Thioacetic Acid.

The reaction between nitriles and thioacetic acid under the action of hydrogen chloride may be considered to take place in such a way that at first hydrogen chloride acts upon thioacetic acid, yielding hydrogen sulphide and acetyl chloride, and then the hydrogen sulphide thus formed acts upon nitriles to form thiamides, rather than that thioactic acide reacts directly with nitriles. To make this point clear, 3 g. of thioacetic acid in 30 c.c. of absolute ether were saturated with dry hydrogen chloride, and left to stand in the ice-chest for 12 hours. On driving ether and hydrogen chloride out of the solution by passing a slow current of dry air through it, it was, however, found that nearly all of the original amount of thioacetic acid remained invariable.

The author wishes to express his sincere thanks to Prof. M. Matsui in The Kyoto Imperial University for the interest he has taken throughout in this investigation and to Dr. I. Wada, the head of Wada Research Laboratory in the Institute for his kind help in this work.

GENERAL NOTES.

GOVERNMENT TESTS OF FOREIGN COAL DISTILLATION SYSTEMS.

A suggestion that the investigation of foreign processes of low temperature carbonisation by the Fuel Research Department was " simply a means of intimidating the progress of British plants now on a commercial scale " was made by Mr. G. D. Hardie, M.P., for Springburn (on Tuesday, March 27) in questioning Commodore King, the Secretary for Mines, concerning the progress of coal distillation in this country.

Commodore King replied that the research was for the benefit of the coal industry.

Mr. Hardie further asked whether it was not a fact that we had commercial plant working in this country, and that the effect of the excuse that we were getting something from other systems was to keep gack British interests and help the financial interests of Germany.

No reply was given.

CONCRETE AS A FIRE-RESISTING MATERIAL.

The fire-resisting properties of Cement and Concrete are interestingly illustrated by an account of a fire that took place at Hull a few weeks ago, "says" *Modern Building Construction.* The concrete walls shewed very plainly that they were not in the least degree damaged and had withstood the heat in such a manner that rebuilding operations be commenced on them imediately. One eye-witness of the fire said " The concrete walls not only beat the flames but successfully confined them to the one house, although the timber work appeared to melt, and the plaster was stripped from the walls." Here is another instance where the superlative merits of conqrete, when made with a good, sound and dependable cement have been provedl complete fire-resisting.

CANADIAN GOVERNMENT TO ERECT RESEARCH LABORATORIES.

The Hon. James Malcolm, M.P., Minister of Trade and Commerce, announced in the House of Commons at Ottawa recently that the Dominion Government intends to erect in Ottawa, on a ten-acre plot at the Dominion Experimental Farm, the first unit of a National Research Laboratory

together with a central power plant. The amount of $750,000 appearing in the estimates was put in at the suggestion of the Honorary Advisory Council for Scientific and Industrial Research, and was considered to be sufficient for the first year's programme. After going over the whole matter with the Advisory Council, it was estimated that about $3,000,000 would be required during a period of from five to ten years to construct at Ottawa the laborities necessary to carry on this work. The Advisory Council also asked for an increase from $170,000 to $300,000 in the funds provided for administrative purposes, and this increase was to be found in the estimates.

CHEMICAL FERTILIZERS FOR CANADIAN WHEAT LANDS.

Acording to Mr. W. J. Stephan, the Provincial Field Crop Commissioner of Alberta, wide-spread experiments to determine the effects of super-phosphate fertilizers on the crops of Western Canada are to be carried out this spring. The Government of Alberta is co-operating with the Experimental Farms of the Dominion Department of Agriculture and with the Canadian Pacific Railway Company in arrangements for experimental work to be carried out not only at Government institutions but by individual farmers.

Mr. Stephan states that at the Tadanac Smelter of the Consolidated Mining and Smelting Company of Canada, Ltd., at Trail, B. C., a million tons of this fertilizer could be obtained annually at a nominal price. The super-phosphate would be used to the extent of 50lbs per acre, which amount would cost 90 cent delivered.

DISTRIBUTION OF TEN MILLION TREES BY ONTARIO GOVERNMENT.

The Government of Ontario is this year offering ten million seedlings, mostly pine, for free distribution to aid re-forestation. Up to 3,500 forest trees are offered to any resident of the Province as well as 500 for windbreaks. It is expected that at least three-quarters of the amount offered will be used for private planting. The remainder will be devoted to supplying the needs of county and township forests.

Free distribution of Government trees, grown at nurseries in Ontario, started in 1907 and now amounts to about 30,000,000 trees. About 95 per cent. of this total was made up of pines of the red, white, Scotch and jackpine varieties. Lately white and red pines have formed the bulk of the trees sent out. The demand has been increasing rapidly. In 1921, 225 persons applied and about 2,000,000 trees were distributed. Last year there were over 4,000 applicants.

LARGE INCREASE IN CANADIAN CONSUMPTION OF ELECTRICITY IN 1927.

Official figures just published show an increase of 13 per cent. in 1927 in the amount of central electric station energy marketed and consumed in Canada. The percentage of increase is the same as that recorded in 1926 over that for 1925, while the 1927 consumpton was 28 per cent. in excess of that for 1925.

Central electrc stations in Canada are now producing an average of over a billion kilowatt hours of electrical energy per month, or 12.6 billion kilowatt hours in 1927, compared wth 11.2 billion in 1926 and 9.8 in 1925. Of the 1927 output 87 per cent. or 11 billion kilowatt hours was used in Canada and 13 per cent. or 1.6 billion kilowatt hours was exported.

Of the total energy generated by central electric stations 98½ per cent. was from water power, only 1½ per cent. being from fuel.

SIR WILLIAM CROOKES, FOUNDER OF THE "CHEMICAL NEWS," A PIONEER OF THE SYNTHETIC NITROGEN INDUSTRY.

Sir Henry Rew, K.C.B., in the course of an article in the *Sunday Times* on April 8, accentuates the importance of synthetic nitrogen to agriculture, shewing that one firm has now facilities for extracting from the air 200 tons per day of synthetic ammonia. He says :—

" Thirty years ago Sir William Crookes drew attention to the fact that the supply of the fixed nitrogen, mostly contained in nitrate of soda, which, so far as is known, is to be found in bulk only in Chile, was not inehaustible. He pointed out that in its free state nitrogen ' is one of the most abundant and pervading bodies on the face of the earth,' adding that ' every square yard of the earth's surface has ntrogen gas pressing down on it to the extent of about seven tons." At that time the capture, in other words, the fixation, of nitrogen from the air was ' one of the great discoveries awaiting the ingenuity of chemists.' Ten years

ago Sir William Crookes republished his famous address in a little book entitled '*The Wheat Problem*,' and *stated that the fixation of nitrogen had then been carried out on a commercial scale*."

SHIPPING AT BRITISH PORTS.

Arrivals of vessels engaged in the foreign trade at United Kingdom ports in February showed a small increase as campored with the corresponding month of last year; departures in cargo were 5.3 per cent. larger, but those in ballast 5.7 per cent. smaller. In the coasting trade arrivals and departures rose by 7.8 and 7.3 per cent. respectively; arrivals in ballast fell by 3.4 per cent.

CANADIAN ELECTRIC STATIONS.

Electrical energy supplied in Canada is almost wholly based on water power, the output of hydro-electric stations during 1926 having been almost 99 per cent. of the total of all generating stations and their dynamo capacity (dynamos driven by water wheels) was over 95 per cent. of the total. Nevertheless, the number of fuel-power plants was considerable, aggregating 301. Only 15 of the fuel stations had capacities above 1,000 k.v.a., but they produced over 80 per cent. of the output of all fuel plants.

Of the output of 11,911,039,000 kilowatt hours generated in 1926 by hydro-electric stations, 14 plants with capacities of 50,000 k.v.a. and upwards generated over 70 per cent. The ratio of their output to their maximum capacity was 51.4 per cent., which was considerably higher than for the majority of the stations.

Production of electrical energy increased during the year by nearly 2,000 million kilowatt hours, owing mainly to the rayid increase in the pulp and paper and mining industries.

TWO COMPANIES ORGANISED IN CANADA FOR AERIAL TRANSPORT.

Mr. J. E. Hammell, President of Howey Gold Mines, Ltd., a pioneer of the Red Lake Mining district in North-western Ontario, has just organised Northern Aerial Minerals Exploration, Ltd., and has ordered for the Company four big Fokker monoplanes. Four light cruisers, probably De Haviland Moths, will also be purchased. Captain H. A. Oaks will be Director of the aerial staff and Assistant Manager of the enterprise.

The project is to undertake prospecting by air, sending men to new fields and keeping them supplied.

CANADA AS A COPPER PRODUCER.

The Dominion Bureau of Statistics at Ottawa has just issued its preliminary report on the mineral production of Canada during the calendar year 1927, from which it appears that the total production of copper in Canada last year was 140,141,823 lbs. valued at $17,174,955.

Two-thirds of the total Canadian production of copper in 1927 was derived from the mines of British Columbia, the output reaching 91,685,843 lbs., valued at $11,845,811. The greater part of the remainder was obtained from the nickel-copper mines of the Sudbury district of Ontario, the output reaching 45,334,303 lbs., worth $4,945,823, but a small tonnage was shipped in the form of concentrates from the Eustis mine in Quebec. The production of copper in Quebec totalled 3,121,677 lbs., valued at $403,321.

RAW COAL AGE PAST.

"NEW SCIENTIFIC FUELS MUST SAVE MINING INDUSTRY."

"In twenty years from now probably no one outside the mining districts will ever see a lump of coal," said Sir Granville Ryrie, K.C.M.G., High Commissioner for Australia, when he recently visited the North Metropolitan (London) Power Company's electrical generating station at Willesden. Sir Granville inspected the new boiler installation in which pulverised fuel is used in conjunction with burners of the new dispersive type, which are the invention of a well-known Australian engineer.

"We have to recognise," he said, "that the Raw Coal Age is past. The future of the British minnig industry is bound up with a far more scientific and less extravagant use of the products of coal than has hitherto been achieved.

"For over a century Britain has been squandering her coal resources. Necessity and invention are now combining to induce her to use them economically.

"It is of vital importance to the British Empire, for which during the past century coal has been currency, to be among the first to appreciate the importance of the new developments in the region of pulverised fuels and low temperature distillation."

"THE LANCET" ON SANITATION OF THE DEAD.

"The problem is one which has always confronted mankind, and it is so closely bound up with religious beliefs and social customs that it is difficult to approach it with a dispassionate mind. Even in an age of comparative hygienic enlightenment the mere suggestion of any interference between the bereaved relatives and their dead would give pain and offence to many. Nevertheless, the methods of the disposal of the dead as carried out in this country are far from satisfactory. Prolonged contact of the dead with the living is bad from every point of view, and would be of benefit to everyone if at the earliest possible moment after death the corpse could be removed from the dwelling-house to a mortuary or undertaker's parlour. During the subsequent interval which must necessarily elapse before burial or cremation, decomposition could be prevented by the use of a refrigerating plant,, or, as is so common in America, by the practice of embalming. Instead of embalming, it has been suggested that sanitation of the corpse should be carried out by the injection of formalin or some other antiseptic solution into the main vessels, but it is a question whether this would be desirable or even effective. There is very little evidence that in this country disease is ever propagated by the presence of a corpse under ordinary conditions, and it is doubtful if the injection of antiseptic solutions into the great vessels would render a corpse bacteriologically sterile. Such an injection would effectively allay the bogy of premature burial, but this fear can be dealt with by other means. And there is the real danger that embalming or antiseptic injections might interfere with a subsequent examination of the body should this be considered necessary. One of the great objections to cremation is the possibility this procedure affords of the concealment of crime, and for this reason special precautions must be taken before any body can be cremated. It is conceivable that injections might have a similar drawback, and for this reason, if for no other, they would have to be rigidly controlled. Unless and until cremation becomes general, anything which tends to delay the corruption of a corpse and its resolution into its constituent elements is to be deprecated. The rapid removal of the body from the dwelling-house to some recognised place would fulfil all requirements, and, if this could be combined with a post-mortem examination by an accredited individual, the fear of premature burial would disappear for ever, the concealment of homicide would become more difficult, and medical science would be advanced.—*The Lancet.*

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.

At the meeting held on Thursday, March 15, the following papers were read in title :—

The Design of Coils for the Production of Strong Magnetic Fields. By J. D. COCKCROFT. Communicated by Sir Ernest Rutherford, Pres.R.S.

One of the most difficlt problems in the production of magnetic fields of the order of half a million gauss is to construct a satisfactory coil. Even in the method developed by Kapitza, in which the field is only produced for a fraction of a second, the heating of the coil is a serious limitation, whilst the electromagnetic forces on the coil give rise to stresses in the copper of the order of 7,000 kgms./sq. cm. beyond the elastic limit of ordinary copper.

This paper develops methods for selecting dimensions of coil which will produce the greater field for given power input, and for fixed allowable temperature rise. The dependence of maximum field on temperature rise, internal radius of coil and power of source, is investigated.

A method is developed of calculating stresses in different parts of coil and for designing coil with maximum stability under these stresses. Formulæ are developed for calculating coefficients of mutual inductance of solid coils and a circle in their end plane, mutual inductance coefficients being tabulated and presented in graphical form for a wide range of coil shapes. The forces on a coil of rectangular or stepped section can then be deduced rapidly by simple arithmetical operations, and the shape giving minimum shearing forces selected.

The Band Spectrum of Water Vapour. By D. JACK. Communicated by O. W. Richardson, F.R.S.

The band λ 3428 has been analysed from new measurements. Results show that for this band the emitter has same initial state as for band 3064, and same final state as for bands 3122 and 2875.

Consequenty, band 8428 corresponds to transition 0 ⟶ 1 of vibrational quantum number.

Moments of inertia of emitter have been calculated by least squares, using the expression,

$$F(m) = B(m - \tfrac{1}{2})^2 + D(m - \tfrac{1}{2})^4$$

for mean values of terms, where m corresponds to Heurlinger's "Laufzahl." Results obtained are believed to be accurate.

Initial and final values of moments of inertia for vibrationless state are, $I_0' = 1.633$, and $I_0'' = 1.498$, in units 10^{-40} gm. cm.^{2}. Corresponding nuclear separations of an OH ion are $r_0' = 1.022 \times 10^{-8}$ cm., and $r_0'' = 0.979 = 10^{-8}$ cm.

Statistical Experiments on the Motion of Electrons in Gases. By R. d'E. ATKINSON. Communicated by F. A. Lindemann, F.R.S. 2

Various papers of Prof. Townsend and his assistants are discussed, and his claim that the results are not reconcilable with the Quantum Theory shown to be unfounded. In particular, the presence of metastable states in the term-systems of the gases studied is shown to undermine, at two different points, a theory which has implicitly assumed their non-existence. Numerical discussion of his curves is possible only in very rough form, since experimental methods employed are statistical, and introduce too many unknown quantities; but within wide limits of obtainable accuracy no disagreement is found.

Statistical methods are also criticised on their own merits. In one problem they lead to results in complete contradiction with the principle of conservation of momentum. This is immediately evident, but has not been recognised.

The objections raised by Townsend against the accepted view are shown to rest usually on misapprehension as to the exact implication of the statement he attacks. In particular, his claim that Quantum Theory violates the principle of conservation of momentum rests on his having taken literally a loose, but convenient, phrase in a short secondary summary.

The Light of the Night Sky: Its Intensity Variations when analysed by Colour Filter III. By LORD RAYLEIGH, F.R.S.

The intensity of light of sky at night has been observed by collaborating workers at a nnmber of stations scattered over the world. As in previous work, colour filters are used to separate as nearly as may be the region of the green auroral from the red and blue regions of the spectrum on either side. These are called red, auroral and blue components respectively. The broad result is that the intensity in each component has the same general values and range of intensities (four or fivefold) previously found for England.

Much of the variation is irregular, and has not been found to be correlated at the different stations. The stations were widely separated, and further investigation with stations nearer together is required.

Five years' observation in England appears to indicate a definite annual periodicity, which survives the process of averaging the same month (February, *e.g.*) for each year. Amplitude of variation corresponds to intensity ratio of 1.6. Maximum is in October. The scanty available evidence suggests a similar variation in the S. hemisphere, with opposite phase, maximum in April.

Relativity and Wave Mechanics. By W. WILSON, F.R.S.

The equations of motion of a charged particle can be derived from those of an uncharged (which represent a geodesic in space-time continuum) by substituting for mechanical momentum

$$p\kappa = m_0 g\kappa\lambda \frac{dq\lambda}{d\tau},$$

an extended momentum

$$\Pi\kappa = p\kappa + e\,A\kappa$$

where A is electromagnetic vector potential. This suggests that we regard the world-line of the charged particle as a geodesic in 5-dimensional continuum, in which

$$dq^5/d\tau = e/m_0.$$

In the theory described, the four components of potential $A\kappa$ are identified with components $g_{\kappa 5}$ of the metrical tensor.

With this modified relativity theory as basis, a generalised form of Schroedinger's equation for a single particle is deduced.

When applied to an electron in the field of force of a positive nuclear charge, it appears that the ratio $dt/d\tau$ (t = time and τ = proper time) is not given by

$$\frac{dt}{d\tau} = \left(1 - \frac{v^2}{c^2}\right)^{-\frac{1}{2}},$$

but by an expression approaching this asymptotically as distance of electron from nucleus diminishes.

The Bending of a Centrally Loaded Plate Supported at Two Opposite Edges. By A. E. H. LOVE, F.R.S.

The question is of some importance in connection with the experimental determination of elastic constants, inasmuch as it

has been proposed from time to time to determine such constants, especially of crystals, by measuring, by an interferential method, the central deflexion of a rectangular plate, supported at two opposite edges, and bent by concentrated pressure applied at the centre of one of its faces. No theoretical formula, connecting central deflexion of plate with load, linear dimensions of plate, and elastic constants of load have ever been obtained, even for an isotropic, let alone a crystalline, plate. The object of the paper is to obtain such a formula in the case where the material is isotropic. The problem, a purely mathematical one, is solved completely, and calculated numerical values of central deflexion are tabulated for various values of ratio breadth :length, and for two values of Poisson's ratio for the material.

THE CHEMICAL SOCIETY OF JAPAN.

Papers communicated :—

San-ichiro Mizushima and Takeo Aso : "Electrolytic Conductivity under High Frequency."

Heima Shinozaki : "Studies on Hydrogen Cyanide. Part III. Some Thermodynamic Calculations."

Kuro Nakamura : "Specific Heat of Binary System of Some Organic Solvents."

Kisaburo Tabuse & Masumi Chikashige : "Contribution to the Chemistry of Tellurium. I. Tellurium-Sulphur-Oxide."

Ryuichi Konoko and Masumi Chikashige : "Contribution to the Chemistry of Tellurium. II. Determination of the Transition Temperature of $S\beta \rightarrow S\alpha$ in the Solid Solution of Small Quantity of Tellurium in Sulphur."

Shunji Tsurumi : "Microanalysis of Carbon and Hydrogen."

Eiichi Funakubo : "Studies on Indol-derivatives of Arsenic. Part V. Reaction between Indolylmagnesiumiodide and Inorganic Arsenic Compounds.

Eiichi Funakubo : "Studies on Indol-derivatives or Arsenic. Part VI. The Molecular Compounds of Arsenic Halogenide and Indol."

THE WIDER ASPECTS OF COSMOGONY.

THE UNIVERSE SLOWLY MELTING AWAY.

At the Royal Society of Arts, John Street, Adelphi, London, on March 7, 1928, Dr. J. H. Jeans, Secretary of the Royal Society, in his Trueman Wood lecture on "The Wider Aspects of Cosmogony," said the evidence of geology, and of radio-activity in rocks in particular, showed that the earth must be something like 2,000 million years old, which was several thousand times the age of the human race.

"In all probability the life in front of the human race must enormously exceed the short life behind it. A million million years hence, so far as we can foresee, the sun will be much the same as now, and the earth will be revolving round it much as now. The year will be a little longer, and the climate a lot colder, while the rich accumulated stores of coal, oil, and forest will have long been burnt up; but there is no reason why our descendents should not still people the earth.

"Perhaps it may be nnable to support so large a population as now, and perhaps few will desire to live on it. On the other hand, mankind being 3,000,000 times as old as now, may—if the conjecture does not distress our pessimists too much—be 3,000,000 times as wise."

Dr. Jeans said that the sun was wasting daily—he put its wastage at 360,000 million tons—and the radiation of the stars was imposing an endlessly recurring capital levy upon their masses. It made the stars poorer, but it tended to equalise the wealth that remained. Observation and theory agreed in indicating that the universe was melting away into radiation. Our position was that of polar bears on an iceberg that had broken loose from the icepack surrounding the pole, and was inexorably melting away as the iceberg drifted to warmer latitudes and ultimate extinction.

"In the 1,000 million stars surrounding our sun there are, at a moderate computation not more than 10,000 planetary sytems, because there has not been time for more than this number to be born. They are of course still coming into existence; calculation suggests a birth rate of about one per 1,000 million years. Thus we should have to visit thousands of millions of stars before finding a planetary system of as recent creation as our own, and we should have to visit millions of millions of stars

before finding a planet on which civilisation and interest in the outer universe were as recent a growth as are our own. We are standing at the first flush of the dawn of civilisation, and are terribly inexperienced beings.

" It may be suggested that the creation of planetary systems is also only beginning, and that in time every star will be surrounded, like our sun, by a family of planets. But no; the stars will have dissolved into darkness before there is time for this to happen. So far as we can judge, our part of the universe has lived the more eventful part of its life already; what we are witnessing is less the rising of the curtain before the play than the burning out of candle-ends on an empty stage on which the drama is already over. There is not time for many more planets to be born."

CORRESPONDENCE.

AN INSTANCE OF MULTIPLICATION BY PROPORTION.

The proportion employed is 68143, and the part which is added to the multiplicand is 3, although it is preferable to use a number containing several figures. The two original numbers are associated so as to contain figures in common and adjusted by proportion. The actual multiplicand is the sum of the differences or the average difference of the associated number with the part interpolated in successive positions and the number. The product of the multiplicand and 68143 should contain the product of the two original numbers. In most cases where no special precautions are taken, the product is found in the logarithm of the fragment of the product of the proportion.

(1) 5584 and 8763. Associated number 558768778.
 Sum of differences = 44983141565.
 Product of 68143 = 2840360507838795.
 Log_{10} 8403605 = 9244657 = 18489314/2
 Arithmetical product = 48932592.
 Average of the above differences = 499812684.
 Produet = 31569672305812.
 Ratio Sr/Fe = 1569305.

(2) 8545 and 391. Associate 853907255.
 30000 (sc9) = 19683(t). 81593698037255
 Product = 5152070874166892465.
 8545 × 891 × 19688 = reciprocal of 15206.

(3) For the system Br/I, RC = 53.82 and K24.02.
 4844284 × 68143 = 30568268. 8820 is RC for the system Br/Cl.

The logarithm 94576 is found in the product of 4838080955 × 68143 = 30549094576.

Numbers can be cancelled like fractions before employing the multiplication.

A. SAKOSCHANSKY, B.Sc.

NOTICES OF BOOKS.

Creatine and Creatinine. By ANDREW HUNTER, M.A., M.B., F.R.S. (Can.) Pp. VIII + 280. Price 14s. net. London: Longmans, Green and Co., Ltd., 39, Paternoster Row.

This is one of the excellent monographs on Biochemistry published by Messrs. Longmans, Green and Company, written by well-known chemists and edited by R. H. A. Plimmer, D.Sc., and Sir F. G. Hopkins, M.A., M.P., D.Sc., F.R.S. In the first four chapters the author gives a general synthesis of Creatine and Creatinine, their general chemistry and derivatives, preparation and quantitative determination, and their distribution and output. The subsequent chapters deal with the metabolic significance of urinary creatinine, the physiology and origin of creatine. In order to bring the work up-to-date, the author gives a special appendix. The bibliography is extensive and given in alphabetical order, and there is a full index. It is notable that while Liebig was not the actual discoverer of Creatine he deserves a prominent place as one of the pioneers in demonstrating its presence in the muscles of most, if not all, vertebrates. The present work is the most useful yet published on the subject and hence is certain of a wide circle of readers.

The Sixth Sense and Other Studies in Modern Science. By D. F. FRASER-HARRIS, M.D., D.Sc., F.R.S.E. Pp. 174. Price 5s. net. London: George Routledge & Sons, Ltd., Carter Lane, E.C.

This is a fascinating book in many respects, the author handling in a scientific manner many subjects which belong to the realms of popular beliefs and superstitions. Thus, dreams and dreamings, our unseen foes, the modern dinner, to mention just a few of the subjects treated by the author. It is interesting to note that as the author points out, persons congenitally blind never " see " things in dreams, as visual registrations have never been made and hence none can be reproduced.

The Chemistry of Chemotherapy. By G. MALCOLM DYSON, Ph.D. Pp. 272. Price 37s. 6d. London: Ernest Benn, Ltd., Bouverie House, Fleet Street, E.C.

The experienced author tackled a big subject when he set out to write a book under the comprehensive term Chemotherapy. Consequently he found it essential if he were to keep the book to moderate dimensions, to boil down and in fact just touch the fringe of many parts of his subjects. One definite result is the almost entire absence of details of symptoms, while little space has been devoted to bibliography. In ten chapters there has, however, been compressed a good deal of interesting matter, especially to the practical chemist to whom detail is of little value.

GERMAN TRADE IN FEBRUARY.

Imports of merchandise into Germany during February reached a value of 1,250 million marks, or 110 million marks less than in January. Exports, at 942 million marks, showed a rise of 80 million marks, chiefly due to finished goods.

FORTHCOMING EVENTS.

INSTITUTION OF MINING AND METALLURGY.

The Annual Dinner will be held at the Hotel Cecil (Victoria Hall) on Tuesday, May 8, at 7.45 p.m. Tickets, 12s. 6d. each, excluding wine. Office: Cleveland House, 225, City Road, London, E.C.1.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

36, George Street, Manchester.

Tuesday, April 24, at 5.30 p.m.—Annual Meeting.

ROYAL INSTITUTION.

21, Albemarle Street, London, W.1.

Friday, April 27, at 9 p.m.—" Carriers of Electricity in the Atmosphere." By Professor A. M. Tyndall.

ROYAL SOCIETY OF ARTS.

Monday, April 23, at 8 p.m.—(Dr. Mann Lecture). A. G. Huntley, of the May Con struction Co., Ltd.: " Applied Architectural Acoustics." (Lecture II.)

Wednesday, April 25, at 8 p.m.—(Ordinary Meeting). J. M. Ritchie, M.A., Ph.D.: " The Education and Training of the Blind." Captain Sir Beachcroft Towse, V.C., K.C.V.O., C.B.E., will preside.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

9,270.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of condensation products from aldehydes and phenols. March 30th.

9,726.—Clayton Installations, Ltd. — Generating gaseous oxides of sulphur. March 30th.

9,578.—I. G. Farbenindustrie Akt.-Ges. —Reduction of aromatic nitro compounds. March 29th.

9,686.—Kali-Industrie Akt.-Ges. — Production of nitrogen and hydrogen. March 30th.

9,760.—Lush, E. J.—Hydrogenation of organic compounds. March 31st.

Specifications Published.

261,757.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of condensation products and vat-dyestuffs of the benzanthrone series.

287,604.—Distillers Co., Ltd., and Peake, A. M. Production of citric acid.

263,795.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of acid dyestuffs of the anthraquinone series.

275,983.—Harter, H.—Apparatus for carrying out exothermic catalytic gas reactions.

275,220.—Geigy Akt.-es., J. R.—Manufacture of azo-dyestuffs.

Abstract Published.

284,998.—2 : 3-Aminonaphthoic acid. — I. G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany.

2 : 3-Aminonaphthoic acid is obtained by fusion of 2 : 3-oxynaphthoic acid mixed only with zinc chloride-ammonia. Under these conditions the reaction mass can easily be stirred. The zinc-chloride-ammonia which is used preferably has the formula $ZnCl_2.NH_3$. In one example, the 2 : 3-oxynaphthoic acid is gradually introduced into the fused zinc chloride-ammonia, while in another the latter is fed into the molten 2 : 3-oxynaphthoic acid. Ammonia may be passed over the mass during the reaction. The product is worked up by extracting it with hot hydrochloric acid after washing out the zinc chloride with more

dilute cold hydrochloric acid. Caustic alkali or alkali carbonate is added in slight excess to the resulting hydrochlorid acid solution, which is then boiled, cooled and filtered. The 2 : 3-aminonaphthoic acid is precipitated on acidifying. The product of the fusion does not appear to be the hydrochloride of 2 : 3-aminonaphthoic acid. Possibly it may be an internal salt or an amide.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

GENOZO.

488,639.—*Chemical substances prepared for use in medicine and pharmacy.*—Genatosan, Limited, 43, Regent Street, Loughborough, Leicestershire. March 28th.

FERRONYL BRAND.

488,075.—Chemical substances prepared for use in medicine and pharmacy.—H. R. Napp, Limited, 3 & 4, Clement's Inn, Kingsway, London, W.C.2. April 4th.

HORMOCARDIOL.

488,489.—Chemical substances prepared for use in medicine and pharmacy.—Bayer Products, Limited, 31 to 34, Basinghall Street, London, E.C.2. April 4th.

KIP.

488,817.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes. — Murphy & Son, Limited, The Cedars, Sheen Lane, Mortlake, London, S.W.14. April 4th.

POETRY OF SCIENCE.

POEMS by "OPIFEX"
(A Prominent Scientist.)
Various Phases of Science. Pp. 106.
Cloth, Price 5/-
By Post 5/4
Chemical News Offices,
Merton House, Salisbury Square,
London, E.C.4.

JUST PUBLISHED.

RASA-JALA-NIDHI
or Ocean of Indian Chemistry & Alchemy.
VOLS. I. AND II.

This is the most Comprehensive and Scientific Treatise on Hindu Chemistry, Alchemy and Medicine—a Science almost lost to Humanity several Centuries ago, and now reclaimed by

DR. BHUDEB MOOKERJI, M.A.,
of 41A, Grey Street, Calcutta.

The text is in Sanscrit and English. Neatly bound in cloth; best antique paper. Demy 8vo. About 350 pages, each Volume. To be had of Messrs. Luzac & Co., Great Russell Street, London, and of the Author in India.

ANALYTICAL CHEMIST (INORGANIC) wanted to take charge of important Laboratory abroad. Much experience and highest qualifications essential.

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Of Interest to CHEMISTS, DRUGGISTS, and Others.

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CONTENTS. PAGE.

The Action of Copper on Sulphuric Acid ... 257
By G. Fowles, M.Sc., A.I.C.
The Oil Well at Hardstoff, Derbyshire 260
By Arthur Wade, D.Sc., A.R.C.S.
(Before the Institution of Petroleum Technologists.)
Phosphate Rock in the Three Forks Yellowstone Park Region, Mont. 263
By J. T. Pardee.
General Notes ... 264
Sir Oliver Lodge on the Revolution in Physics ... 267
Society of Glass Technology ... 268
The Geographical Association ... 269
Proceedings & Notices of Societies:—
The Physical Society ... 269
Forthcoming Events ... 271
New Patents ... 271
New Trade Marks ... 272

SOCIETY OF GLASS TECHNOLOGY.

The Eleventh Annual Report, covering the various activities of this useful Society for the year 1927, shews a total membership of 630 on 31 December. The membership is drawn from some thirty different countries which shews the wide and varied interest taken in its proceedings. The finances seem to be in a healthy condition, seeing that the Council had decided to purchase £500 of 5 per cent. War Bonds out of its surplus funds.

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AND JOURNAL OF INDUSTRIAL SCIENCE.

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THE ACTION OF COPPER ON SULPHURIC ACID.

By G. FOWLES, M.Sc., A.I.C.

In calling attention to the still unsolved problem of the action of copper on sulphuric acid (*The Chemical News*, 1928, cxxxvi, 81) Druce has been content to give an account of the present state of our knowledge of this subject as revealed by experiment, and has not introduced complications either by advancing a new conception of the mechanism of the reaction, or by strenuously advocating the merits of an existing one.

To account for the formation of the sulphur dioxide, it is necessary to assume the existence of a reducing agent, and the number of theories which have been put forward to explain the reaction is measured by the number of actual or hypothetical reducing agents the system can produce: hydrogen, copper, cuprous sulphide, and cuprous sulphate have all been used. In the present paper it is shown that the familiar nascent hydrogen theory is no longer tenable, but it is maintained that once the action has commenced the production of sulphur dioxide is due to the simultaneous action of three reducing agents, copper, cuprous sulphide and cuprous sulphate; moreover, attention is called to some papers which, though not dealing with this problem, contain information helpful for its solution, and some criticism is offered of the views of Rogers*, of Cundall* and of Druce.

The nascent hydrogen theory assumes that the usual displacement of hydrogen by a metal occurs and that the sulphuric acid is decomposed by this powerful reducing agent. Against this it may be pointed out that hydrogen has never been found amongst the reaction products and some should surely escape as molecular hydrogen. Again, copper stands below hydrogen in the electrochemical series, and Ipatiev has recently shown that under pressure this gas can precipitate copper from a solution of copper sulphate, a behaviour in accordance with the position of copper in the series. A product which forms in considerable quantity in the action of copper on sulphuric acid is cuprous sulphide and a favourite argument is to attribute its formation to the action of nascent hydrogen on the copper sulphate likewise produced in the action; now when magnesium is placed in a solution of copper sulphate a system is established producing nascent hydrogen, yet no cuprous sulphide appears, the products being copper and a basic sulphate. Finally, the crucial experiment mentioned in the

School Science Review, 1927, XXXIV, 90) seems definitely to refute the nascent hydrogen theory; when cuprous sulphide is placed in a system producing nascent hydrogen, action immediately occurs, hydrogen sulphide being evolved in abundance. These experiments and arguments show that the retention of the nascent hydrogen theory is no longer helpful.

The oxidation theory which was first advanced by Andrews* considers the sulphuric acid as an oxidising agent reduced by the copper, parallel to its reduction by sulphur and carbon. This theory is in accordance with known facts: heat breaks up the acid into water, sulphur dioxide, and oxygen, and in molecular reactions of this type it is a familiar experience that chemical agency effects decomposition at those points where thermal decomposition has shown that the linkages are weak. Certainly the theory seemed discredited when Sluiter (*Chemisch Weekblad*, 1906, p. 63) found that the mixture of copper and acid at 130° C. would reduce nitrobenzene to aniline, which behaviour he considered could only be explained by assuming the presence of nascent hydrogen; but the existence in the solution of cuprous sulphate (first pointed out by Cundall in 1914) was unknown to him. There is therefore no ground for abandoning the oxidation theory, but it is necessary to include the new knowledge, and to account for the total amount of sulphur dioxide evolved the reduction of the acid by cuprous sulphate and cuprous sulphide must be included.

Such a conception of the total reaction was apparently contemplated by Cundall, but he did not live to publish his work and the editor of his posthumous paper, in attempting to indicate the paths by which the final products could be reached, made use of equations which seem unnecessarily complicated. Thus, to account for the formation of cuprous sulphate Cundall and Fairgrieve gave the two equations reproduced in Druce's paper (this Vol., p. 82), but the reduction of copper sulphate (in neutral or acid solution) to cuprous sulphate was already well established from other investigations (Förster and Seidell, *Zeit. anorg. Chem.*, 1897, XIV, 106, 196; Abel, *Ibid.*, 1901, XXVI, 361), and the simple well accredited reaction

$$Cu + CuSO_4 = Cu_2SO_4$$

is preferable to the complicated imaginary ones. Again for the reduction of sulphuric by cuprous sulphate it seems desirable to substitute the simple action

$$Cu_2SO_4 + 2H_2SO_4 = 2CuSO_4 + SO_2 + 2H_2O$$

in accordance with the action of cuprous chloride for the conjectural path indicated by Cundall and Fairgrieve (see Druce *loc. cit.*, p. 82).

A difficulty which confronts all who would attempt an explanation of the mechanism of the reaction is the necessity of accounting for the considerable amounts of cuprous sulphide which appear. Its formation is generally attributed to the direct action of the copper on the acid, an action requiring the concurrence of nine molecules :—

$$5Cu + 4H_2SO_4 = Cu_2S + 3CuSO_4 + 4H_2O$$

Cundall assumes that it not only results from this reaction, but also from the reduction of the acid by cuprous sulphate, but this last assumption of his finds no support from the parallel action of cuprous chloride, for I heated this in sulphuric acid between 100° and 170° (temperatures favourable to its formation) and none was observed, although sulphur dioxide was abundantly evolved. Now it has been strangely overlooked that the reduction of sulphur dioxide and sulphurous acid by copper with the production of cuprous sulphite has been mentioned several times in the literature; Geitner *Liebig's Ann.*, 1864, cxxviii, 350; Caussc, *Bull. Soc. Chim*, 1886, (2) XLV, 3; Berthelot, *Ann. Chim. Phys.*, 1898, (7), XIV, 203. Thus once again an hypothetical reaction has been utilised to the exclusion of a simple one already known and established by experiment.

According to Rogers* (the date of his paper is misprinted in Druce's article, it should be 1926) the formation of sulphur dioxide is entirely due to the action of cuprous sulphide on sulphuric acid; unfortunately, the paper of Cundall had escaped his notice or he would probably have extended his theory to include the action of the cuprous compound in solution. Rogers made a thorough study of the various solid phases which appear and of the changes which they undergo; he is the first to point out that the anhydrous copper sulphate is precipitated in several forms and is at least dimorphous. When copper is placed in sulphuric acid Rogers noticed that the first visible change is the formation of a film of cuprous sulphide on the copper, and his theory of the action is based wholly on the assumption that this first visible change is a true indication of the first chemical change which occurs. Rogers supported this by a series of experiments at 50° to 85° in which he attempted to show by quantitative measurements that no sulphur dioxide was evolved before the appearance of this film of cuprous sulphide, hence he argued that the

appearance of the film was an indication of incipient action. The results are far from convincing, for the action at these temperatures is very slow, and its occurrence, as judged by a quantitative estimation, would be missed or rendered doubtful in the limits of experimental error. Moreover, Rogers omitted two possibilities : the small amount of sulphur dioxide may have been retained in the acid in some form such as $CuH_2(SO_3)_2$ or, it may have been reduced to cuprous sulphide as fast as it was formed. It would be instructive if Rogers were to repeat his experiments with a modified procedure, namely, testing the liquid for sulphur dioxide, likewise ascertaining whether any copper was in solution or embedded in the cuprous sulphide as insoluble copper sulphate, instead of attempting to estimate the sulphur dioxide evolved, for if the oxidation theory holds both these substances must form before the appearance of the cuprous sulphide.

Druce says (p. 83) that when copper and sulphuric acid are heated together in the proportion 1 : 2 the main reaction at temperatures 130° to 180° is represented by :—

$$6Cu + 6H_2SO_4 = 4CuSO_4 + Cu_2S + SO_2 + 6H_2O$$

Cundall also gives this equation but with the necessary stipulation that there must be excess of copper, otherwise, as shown by Rogers (*loc. cit.* 266) if the action is allowed to go on at this temperature all the copper sulphide eventually disappears the final action being

$$Cu + 2H_2SO_4 = CuSO_4 + 2H_2O + SO_2$$

except that the amount of sulphur dioxide falls short of the equational quantity owing to some sulphur volatilising or becoming inactive. The equation of Druce can therefore only hold at a point of time, and scarcely between the temperature limits he indicates, during which the ratio Cu_2S : $CuSO_4$ changes considerably (see Baskerville*). Moreover, it is open to the objection that it ignores the presence and action of the cuprous sulphate. Druce seems to expect this criticism and attempts to meet it by pointing out how trifling was the amount of cuprous sulphate which Cundall obtained compared to the significance he assigned to its presence. Now the concentration of cuprous sulphate at any moment is only a fraction of the total amount formed in the reaction, since it is a reactive and rapidly changing intermediate product; and the concentration is not so trifling as Druce imagines. It was pointed out (Fowles* *loc. cit.* p. 8) that Cundall lost most of his cuprous sulphate by allowing the contents of his flask to cool before precipitating the copper; in repeating his experiments but precipitating from hot solutions I have obtained evidence of much larger amounts; thus working at a temperature of 180° with 95 per cent. acid the copper precipitated was .8 per cent. corresponding to 2.5 per cent. of cuprous sulphate.

From the above considerations it seems preferable to represent the reaction by a series of equations and not by the complex one of Druce, although this has approximately a quantitative basis. The employment of such an equation seems to represent our knowledge of the reaction as complete, whereas, a series of equations revealing the mechanism of the action, as far as it is known, would stimulate further investigation, because alternative routes are possible by which the same end products may be reached, and some of these could be explored in side experiments. I venture to suggest the following series of equations as most closely expressing our accumulated knowledge of the reaction :

$$Cu + H_2SO_4 = SO_2 + H_2O + CuO\ (CuSO_4)$$

then two simultaneous reductions :—

$$4Cu + SO_2 = Cu_2S + 2CuO\ (2CuSO_4)$$
$$Cu + CuSO_4 = Cu_2SO_4$$

Next the reduction of sulphuirc acid by cuprous sulphide either by the equations suggested by Rogers or the following alternative series :—

$$Cu_2S + H_2SO_4 = Cu_2SO_4 + H_2S$$
$$H_2S + H_2SO_4 = 2H_2O + SO_2 + S$$
$$S + 2H_2SO_4 = 2H_2O + 3SO_2$$

Concurrently the reduction of the acid by cuprous sulphate

$$Cu_2SO_4 + 2H_2SO_4 = 2CuSO_4 + SO_2 + 2H_2O$$

These taken in appropriate multiples add up to the simple equation

$$Cu + 2H_2SO_4 = CuSO_4 + SO_2 + 2H_2O$$

* These references are given in Druce's article (this volume, p. 83)

SAFEGUARDING OF KEY INDUSTRIES.

The Treasury have made an order under Section 10 (5) of the Finance Act, 1926, exempting the following articles from Key Industry Duty from 13 April 1928, to 31 December, 1928—Acid hydrocyanic anhydrous; Acid lactic which satisfies the requirements of the British Pharmacopœia ! Metaldehyde; Methyl chloride; R. Potassium chlorate; and Synthalin.

being arranged at the top of the casing for this purpose.

From 2,600 ft. an open hole was drilled *for 6⅝-in. casing until caving shales became* dangerous. However, by inserting the 6⅝-in. casing, drilling ahead with a 6-in. bit and under reaming, good progress was made. The two bottom lengths of the casing were perforated.

It was expected that the oil sand would be met with at around 3,050 ft. but nothing but a trace of oil was found at the producing horizon of the No. 1 well and at a depth of 3,056 ft. The hole was carried to 3,125 ft. where a strong flow of salt water was struck, continued to 3,130 ft., where, owing to a troublesome influx of sand, drilling ceased. This water kept a constant head of 2,800 ft. in the hole and could not be bailed down. The well was, therefore, plugged with cement and abandoned on March 24, 1925, though the gas from this well is still being utilised. The actual time spent in drilling No. 2 was 313 days, but fishing jobs and under reaming took up nearly half of that time.

At 3,825 ft. boring at No. 3 well was abandoned as useless, no oil being found.

THE ORIGIN OF THE OIL.

Seepages, drippings and even small flows of petroleum are very frequently met with in the coalfields that lie around the southern end of the Pennines. New occurrences are reported every year and almost invariably with fault planes. The oils are so similar in character to that found at Hardstoft that there has been some tendency to look for the origin of the oil in the coal measures. But though there is no difficulty in accounting for upward or even lateral migration of petroleum it is difficult to imagine migration to beds below, especially through shales and waterlogged strata. Graham and Skinner have endeavoured " to throw light on the mode of formation of these occasional drippings " and to " ascertain how far the composition and properties of the oils found naturally compare with those of oils obtained by the destructive distillation of various carbonaceous materials at the lowest temperature at which decomposition is found to take place with the production of oil in appreciable quantity." The authors had in mind that geological disturbances, such as faults, might produce temperatures capable of resulting in distillation of carbonaceous material. The authors were able to prove as a result of their investigations " that the natural oil . . . owes its existence to causes other than the destructive distillation of carbonaceous material." In other words the oil is quite independent of the coal so far as its source of origin is concerned.

Looking into the question in connection with the Carbon Ratio Theory I find from the analyses available to me that the Carbon Ratios of coals taken from seams worked in the Derbyshire field run between 63.5 and 70. Such ratios are found in connection with gas and traces of oil by theorists. It looks as though the theory works very well in this area. It is sometimes objected that the Carbon Ratio is unscientific. So are many theories in science. The only pertinent question that need be asked is: "Does the theory work?" It does work *very well in many observed cases and what* is more important to myself is that it has worked in cases where I have been able to use in the field. If we may draw any conclusion from the application of the theory it is that we must look for the source of origin of oil elsewhere than in the Coal Measures, which agrees with the conclusion arrived at on other grounds.

Bromehead, after classifiying petroleums as:

(1) Those with a paraffin base indigenous to shales;

(2) Those with an asphaltic base indigenous to limestones;

comes to the conclusion that the petroleum at Hardstoft originated in the lower part of the Limestone Shales (Yoredales) " which," he says, " are black in colour and of an ' oily ' appearance and occasionally show little veins of black bitumen in the bedding." While I hesitite to accept his classification of the petroleums as being completely established there is much to he said in its favour. Observers have noted for well over a hundred years many instances in the area around the Peak of the occurrence of petroleum near the junction between the base of the Limestone Shales and the underlying Mountain Limestones.

FUTURE PROSPECTS.

To come to the conclusion that the first bore to be commenced under the Government scheme for the purpose of seeking for oil in England, struck the only large supply that exists, or can possibly exist, would be absurd. Such a borehole is but a pinprick on the surface of the country and to imagine that such a pinprick discovered all that is to be found in the length and breadth of only the Northern Midlands would be to imagine a vain set of improbabilities. If my reasonings are correct it is almost certain that more oil is to be obtained, possibly in larger quantities than those already yielded

by No. 1 Hardstoft, along the same fault plane and at the same horizon. There is no reason to doubt that similar accumulations exist in favourable situations elsewhere. Dr. Veatch, who is a petroleum geologist of the highest standing, states that "the petroleum possibilities of the Midlands of England were of a most amazing and striking character." In spite of the failure of the Government test borings both Veatch and Ickes think that profitable oilfield areas can be discovered. Ickes says that "the writing off of the expenditure already incurred as a loss is premature," and considers that more work should be done.

It appears to be certain, therefore, that accumulations of petroleum possibly of comparatively large dimensions remain to be discovered in England. The main problem is whether it will be a profitable business to seek for such accumulations and this, at present, is where doubts arise. In the first place our optimism must be largely based upon the results obtained in Hardstoft No. 1, and this is rather an unsatisfactory basis. If the oil accumulation there had been a simple oil pool associated with a normal structure it would have given much more confidence. Many good structures were drilled and were found to be barren from a commercial point of view. Seeking for oil accumulations against faults is much too complicated and risky a business to be undertaken for commercial purposes at present. Moreover, I do not think that any concern could be persuaded to spend the very considerable amount of money that would be required in endeavouring to find suitable structures on the oil sands at Kelham and Retford.

The conclusions I come to at the end of this chapter are that although I am sure that accumulations of oil do exist in the Midlands of England, I am also quite sure that to look for them is not at present a commercial proposition. Some day either when there is a dearth of fuels or in some case of national emergency the search for oil in England may be commenced again.

PHOSPHATE ROCK IN THE THREE FORKS-YELLOWSTONE PARK REGION, MONT.

By D. Dale Condit, E. H. Finch, and J. T. Pardee.

Preparation of the Report.

The following report includes part of an unpublished manuscript writen by D. Dale ... field examination, in 1916, of a large area in southern Montana. Before their report was prepared for publication these authors severed their connection with the United States Geological Survey. The part of that manuscript relating to the phosphate deposits and their closely related geology has been assembled and reviewed by J. T. Pardee, who, in 1924, visited some of the localities described. In this work, except for rearranging the material, no noteworthy change has been made in the text.

Summary.

The region described is about 7,000 square miles in area. It includes most of Gallatin and Madison Counties, in Montana, and some contiguous parts of Idaho and Wyoming. Within it are several broad fertile valleys and a number of prominent mountain ranges. A considerable part is underlain by a bed of phosphate rock which occurs in the Phosphoria formation, of Permian age, and is elevated to the surface of the mountainous area. In most of the midlle and southwestern parts of the region this deposit is about 2 feet thick; locally it is 3 feet or more. Outcrops of beds in which the deposit is more than 6 inches thick aggregate more than 200 miles in length. Toward the northeast the deposit thins out, and its limit in that direction is represented fairly accurately by a line drawn from Yellowstone Park northwestward through Salesville to Willow Creek, on Jefferson River. Its thickest parts contain 45 to 65 per cent. of tricalcium phosphate.

In this region the phosphate deposit is thinner and of poorer quality than in the adjoining parts of Montana on the west and northwest, where it is commonly 4 feet thick and contains 65 to 70 per cent. of tricalcium phosphate. In southwestern Idaho the deposit is still thicker and richer.

Nature and Scope of the Report.

It has been known for a number of years that important phosphate fields lie to the west and southwest of Helena, Mont., near Elliston, Garrison, and Drummond, and also to the south of Melrose, through reports of Gale, Pardee, Richards, and Stone. The extensive fields in Idaho, Utah, and western Wyoming have been mapped by Gale, Richards, Schultz, Blackwelder, Mansfield, Richardson, Condit, and others. There remained unexplored a large intervening area in southwestern Montana and the western part of Yellowstone Park, compris- ...

extensive outcrops of the Phosphoria formation, suspected of containing beds of phosphate rock. It was with the object of ascertaining the extent and value of the phosphate beds in this area that the field work summarized in this report was undertaken.

MINERAL AN CHEMICAL COMPOSITION.

A close examination of the phosphate rock reveals the fact that the phosphatic material occurs in three principal forms—oolites or irregular pebbly masses; deposit replacing fossils, chiefly molluscan forms; and secondary growths filling interspaces between mineral grains or forming irregular veinlets. Many of the smaller oolites are made up of concentric layers, as shown by the banded appearance seen in cross section under the microscope, and some contain central nuclei of foraminiferal shells of the genus *Textularia?* and less frequently *Globigerina*. More commonly such shells are absent, and as a rule no specific nucleus is distinguishable.

The *Lingulidiscina* shell fragments, seen in cross section, show a finely laminated structure, are brownish to white, have a waxy luster, and show no distinct cleavage. The fracture is regular, given even, smooth, faces. The hardness is considerably less than that of apatite . W. T. Schaller, who made a qualitative examination of shell fragments collected from the Wind River Mountains near Lander, makes the following statement :

" The mineral is essentially a phosphate of calcium but contains also water (H_2O), carbonate (CO_3), and sulphate (SO_3). The refractive indices are approximately 1,598 (parallel to laminae) aud 1.602 (normal to laminae), which are lower than those of the known related minerals."

The precise mineral composition of the oolite phosphate is especially difficult of determination owing to the mode of occurence of the mineral constituents. Cross sections viewed under the microscope commonly show the concentrically banded oolites to consist of an aggregate of cryptocrystalline mineral particles with inclusions of quartz flakes and other foreign substances. Some of the banded zones show a crystalline, fibrous structure with isotropic bands of a phosphatic mineral having an index of refraction suggesting collophanite, the formula of which is given as

$$x(Ca_3PO_4)_2 \text{ or } x[(CaF_2)Ca_3PO_4)_6 + yCaCO_3 + H_2O].$$

A large number of analyses made by R.

phosphate rock from this region show the presence of different amounts of phosporic acid (P_2O_5) up to 83 per cent. Apparently most if not all of this substance exists in combination with lime (CaO) as tricalcium phosphate ($Ca_3P_2O_8$). From microscopic examinations it is evident that the bulk of the residue is silica (SiO_2). As a rule small amounts of iron oxides (reckoned as Fe_2O_3) and alumina (Al_2O_3) are present. The analyses of four samples show from 0.33 to 1.42 per cent. of iron oxides and from 0.38 to 3.51 per cent. of alumina. Qualitative tests on a composite of the same four samples showed some water remaining after the material had been heated to 100° C., considerable carbon dioxide (CO_2), a little fluorine, sulphate (SO_3), sodium, and potassium, and traces of chlorine, lithium, and barium. No strontium or rare earths were detected. Two separate samples contained 0.31 and 0.58 per cent. of fluorine.

These analyses indicate the presence of the minerals calcite, apatite, and barite, which would yield, respectively, the carbon dioxide, the fluorine, and the sulphate and barium. Probably the sodium, potassium, and lithium are present as chlorides, though they may occur also as silicates.

GENERAL NOTES.

SCIENCE AND BUILDING.

By invitation of the Association of Architects, Surveyors and Technical Assistants, there was a large gathering at the Building Exhibition, Olympia, London, on April 14, to hear an illustrated lecture by Dr. R. E. Stradling, Director of Building Research, Department of Scientific and Industrial Research, on the work of the Building Research Station at Garston, Herts.

Dr. Stradling said that in the majority of our buildings the construction was much too heavy, when judged from strength requirements alone, and this extra weight had become traditional because of the other factors required for construction. The requirements of weathering resistance, heat insulation, and the like made demands often very much more serious than that demanded by strength.

The general work of the Research Station was divided into four sections : weathering, materials, structural strength, and efficiency of buildings. The testing of building materials was as yet in its infancy and no applied science could develop satisfactorily unless

experience. The Building Research Station existed to help the industry, but this could not be done effectively unless the industry joined hands in the work. They wanted members to visit the station and realise what was being done; they wanted opportunities for the staff of the Research Station to visit jobs where troubles arose, for they could learn much from failure. They wanted also to join hands with the manufacturers of building materials so that specifications could be made possibly in scientific terms instead of trade names. The only real safeguard for the user of materials at the present time was intelligent specification, a specification which defined the material in such a way that it should be satisfactory for the purpose for which it was desired. He was not appealing for paid investigations, but for co-operation to get more scientific work into building.

THE NEW WORLD FINANCE COMBINE AND CHEMISTRY.

It would be difficult to over-estimate the importance, not only to British industries, but to the industries of the whole Empire and of the world at large, of the formation of the new Finance Company of Great Britain and America. It represents an alliance of British and American industrial and banking interests on an unprecedented scale.

In the new corporation the largest single producing unit in the British Empire—Imperial Chemical Industries Ltd.—is allying itself with the biggest banking interests in the United States—the Chase Securities Corporation of New York and the Chase National Bank.

The chemical combine has a capital of £65,000,000, and includes over a hundred companies with branches, factories, agencies, etc., all over the world. The Chase Securities Corporation has over 4,000 branches and commands assets amounting to £200,000,000.

INDUSTRIAL REORGANISATION.

The Conference on Industrial Reorganisation and Industrial Relations, composed of the Representative Group of Employers and the General Council of the Trades Union Congress, has already reached agreed statements on a number of items on the agenda. In view of the urgency of the matter, it was decided to communicate immediately an agreed memorandum on the Gold Reserve and its Relations with Industry to the Chancellor of the Exchequer.

The following resolution was passed :—

" (a) That under the special conditions in which the gold standard operates at the present time, we are not convinced that it is either practicable or desirable that the credit policy of the country should be determined more or less automatically by gold movements as in pre-war days.

(b) That it is highly undesirable that the Bank of England should be so tied down by the provisions of a gold reserve law as to be unable fully and freely to co-operate in the plans adopted by this country and the rest of Europe at Genoa, 1922, for international co-operation in economising the use of gold, regulating its distribution, and preventing undue fluctuations in its value in terms of wealth.

(c) That it is therefore essential to hold a full Enquiry into the best form of credit policy for this country, before decisive steps are taken by the Government."

INTERNATIONAL CONFERENCE ON BITUMINOUS COAL.

President Thomas S. Baker, of the Carnegie Institute of Technology, Pittsburgh, who has spent two months in Europe in the organisation of the Second International Conference on Bituminous Coal, which will be held at the Carnegie Institute of Technology in November, 1928, sailed for New York on the s.s. " Ile de France," on April 18.

Before sailing, President Baker stated that he was greatly encouraged at the interest that had been shown in the European countries that he visited in the Carngic Congress. He stated that the programme would not be completed for at least two months, but that he had already received tentative acceptances of his invitation to present papers from the following gentlemen :—

From England—Sir Alfred Mond and Messrs. Lander, E. C. Evans, S. W. Smith, Lessing, Sinnatt, Humphrey, Bone.

From France—Monsieur Agachs, President of the Etbas Kahlmann, will be present said Mr. Barr, of his company, will submit a paper as well as Professor Mailhs and Monsieur Bing. There will be a representative from the French Department of Mines, and Messieurs Winckler, Weiss, Cling, Simon, Labeau and Laffont will also be present.

From Germany—Messrs. Krauch, Frantz Pischer, Pett, Rosin, Terres, Bergius, Bittig, Pawlikowski, Fritz Hofmann, Munziger.

From Austria—Professor Fleissner.

There will also be representatives from Spain, Belgium, Holland, Russia, Czecho-Slovakia, Italy and the Scandinavian countries.

The above list is by no means complete, and will be greatly enlarged in the course of the next three months. There will also be papers by representatives of companies that are making use of special processes for the treatment of coal, notably low temperature distillation processes.

The Second International Conference on Bituminous Coal is open to scientists and industrialists of all countries. Fuel technologists who wish to submit papers should communicate with President Thomas S. Baker, Carnegie Institute of Technology, Pittsburgh, U.S.A.

FRENCH TARIFF REDUCTIONS.

Attention is directed to the reduction of the French duties on many classes of goods, including cotton yarns and piece-goods, jute yarns, and linen piece-goods, in force from 15 April as a result of the French Agreements with Belgium and Switzerland.

INTERNATIONAL RELIGHTER SAFETY LAMPS.

At Mines, where, in pursuance of the Coal Mines General egulations (Safety Lamps), 1927, and the Safety Lamps (Relighting) Order, 1927, flame safety lamps fitted with self-contained relighting devices are adopted for the use of officials, a copy of the regulations governing their use must, in accordance with the Order, be posted up in the lamp room.

AGES OF BRITISH MIGRANTS.

In a comprehensive survey of the ages of British migrants between Great Britain and Northern Ireland and non-European countries during 1927, it is shown that of the emigrants from Great Britain and Northern Ireland about 45 per cent. of the males and 38 per cent. of the females were between 18 and 30 years of age. These proportions compare with 42 and 37 per cent. respectively in 1926.

BRITISH OVERSEAS TRADE IN THE FIRST QUARTER OF 1928, 1927, & 1926.

The following table shows the value of the imports into and the exports and re-exports from the United Kingdom during the first quarter of 1928, as compared with the corresponding quarter of 1927 and 1926:—

TOTAL IMPORTS.

Class of Goods.	Jan.-March, 1928. £'000	Jan.-March, 1927. £'000	Jan.-March, 1926. £'000
Food, Drink and Tobacco	132,112	129,352	138,458
Raw Materials and Articles mainly unmanufactured	96,158	104,162	105,019
Articles wholly or mainly manufactured ...	80,156	86,013	76,838
Animals, not for food	418	488	349
Parcel post, non-dutiable	904	920	809
Total Imports	309,748	320,985	321,473

TOTAL EXPORTS.

Class of Goods.	Jan.-March, 1928. £'000	Jan.-March, 1927. £'000	Jan.-March, 1926. £'000
Food, Drink and Tobacco	12,988	12,194	12,654
Raw Materials and Articles mainly unmanufactured	18,050	20,061	20,156
Articles wholly or mainly manufactured ...	147,179	134,329	152,683
Animals, not for food	436	490	475
Parcel Post	3,284	3,399	3,626
Total Exports	181,937	170,473	189,594

SIR OLIVER LODGE ON THE REVOLUTION IN PHYSICS.

On April 19, before the Institution of Electrical Engineers, Sir Oliver Lodge delivered the Kelvin Lecture. He said that the revolution in physics during the present century was such that mathematical speculators were soaring up into the clouds of tensors and matrices, and imaginary operators, and any number of dimensions of space. They dropped perturbing bombs, which when opened contained interesting things, more like seeds than explosives, and those that took root flourished exceedingly. The bombs of the quantum and of relativity were already rooted, accepted, and cultivated, and had led to gravitational and electromagnetic extensions. The older method was to plant a seed quietly in the ground so that its growth could be watched. Radioactivity was one, the electron was another, of those quiet and most fruitful seeds; the Bohr theory of the spectrum was yet another. But how to regard the Schrödinger waves was still a question; in a sense they had developed out of the quantum, but they were more revolutionary than that; while the latest Heisenberg and Dirac bombs were still, he supposed, under examination, and had still to prove their fertility.

Meanwhile wave-mechanics represented the beginning of a comprehensive theory of the ether, which must be contemplated by every one interested in physical reality. If it was a heresy to believe in the FitzGerald Contraction and other things, including the ether, as realities and not merely conventions to suit different observers, then he was a heretic. That a mathematician should be content with the Lorentz Transformation, without seeking to go behind it or interpret it physically, otherwise than from the point of view of various observers, was intelligible enough. But a physicist could not be so easily and pragmatically satisfied. The β factor in the Lorentz Transformation was not in it at first, and then it was not reciprocal. The introduction of the β factor completed the transformation, and that factor was the Fitzgerald Contraction pure and simple.

When a body radiated energy it must lose mass. It could not lose mass continuously, for mass was electric charge, and that was discontinuous. Mass could only be lost in particles, hence energy could only be radiated in quanta. *Continuous radiation* was impossible: it must occur in jerks. It could only be smoothed out on the average by dealing with an immense number of particles—just as gaseous or liquid pressure on the average was uniform, though really intermittent and jerky, as was shown by the Brownian movement when the bombarded surface was small enough.

There might be several different ways of regarding the same essential thing. Electric and magnetic explanations could never be ultimate so long as they could be resolved into something mechanically simpler. A vortex fluid, in which the laws of dynamics held in the innermost parts, however much they might appear, departed from in the gross, was about the simplest view of the substratum of the physical universe that could be imagined, in spite of the difficulty of treating it mathematically.

PRODUCTION OF IRON AND STEEL IN CANADA AT HIGHEST SINCE WAR.

Both in output for February and in cumulative totals for the first two months of the current year, the primary iron and steel industry of Canada shows a sweeping advance over the totals of a year ago. Pig iron production in February was 28 per cent. above the corresponding month a year ago, while for the two months the increase was 26 per cent. The gains in steel output were much larger, 78 per cent. in February and 61 for the two months as compared with the corresponding periods of 1927.

IMPORTANT INDUSTRY WILL UTILISE BY-PRODUCT FROM NEWSPRINT MILLS.

Persistent reports that a plant would be built to manufacture insulating board from by-product material to be furnished by the newsprint mills of St. Maurice Valley Corporation, Canada, are confirmed in the announcement that a new company to be known as National Forest Products Ltd., is to be brought into existence by and will be jointly and equally owned by Building Products, Ltd., and St. Maurice Valley Corporation.

BRITISH OVERSEAS TRADE IN MARCH QUARTER.

Imports of merchandise into the United Kingdom during the first quarter of the year showed a reduction in value of £11,187,000 as compared with January-March, 1927, while exports were £11,464,000, an increase *more than covered by an advance of* £12,850,000 in shipments of manufactures. Re-exports also showed an increase.

CANADA—UNITED STATES LARGEST TRADE BETWEEN ANY OTHER TWO COUNTRIES.

At the present time, the volume of trade between Canada and the United States exceeds that between any other two countries in the world. During the last calendar year Canada's imports from the United States amounted to $707,000,000, and exports to that country to $475,000,000. To some extent, the unbalanced trade between the two countries is offset by the expenditures of United States tourists in Canada. For the past year, these expenditures have been officially estimated at $200,00,0000. One important factor in this trade relationship that has never been properly estimated is the expenditure of Canadians who winter in Florida or California or who spend part of their summer on the coast of Maine.

CANADIAN BUILDING IN 1927.

Contracts for $276,000,000 worth of building construction were awarded in Canada during 1924, for $298,000,000 in 1925, $372,000,000 in 1926 and $419,000,000 in 1927. This trend was particularly marked in Ontario, where the total for 1927 was $196,000,000 as compared with $142,000,000 and $121,000,000 in the two previous years. It may be significant of the special interest which Ontario is taking in encouraging automobile tourists that $25,000,000 out of the $31,000,000 spent in Canada for hotels and clubs last year and half of the total amount spent for roads and streets was expended in this province.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

At the meeting held on April 4, 1928, Sir Merrick Burrell (Vice-Chairman) reported that a memorandum on " Super-English or Baby Beef,55 prepared by Mr. J. Hunter Smith, had been considered by the Committee. Mr. Smith had explained to the Committee the work which had been carried out at the Hertfordshire Institute of Agriculture on baby beef production and his proposals for future experiments.

Various letters had been submitted to the Committee acknowledging the allocation of grants for work to be carried out during the present year.

A letter had been read from the U.S.S.R. Commercial Representative in France as to the trial of Russian sugar beet seed in this country. In view of the Secretary's reply, giving the addresses of the National Institute of Agricultural Botany and the Rothamsted Experimental Station ,the Committee did not consider any further reply necessary.

Proceedings and Notices of Societies.

SOCIETY OF GLASS TECHNOLOGY.—VISIT TO GERMANY, MAY, 1928.

Members are reminded of the exceptionally favourable arrangement which the Society, in conjunction with its friends in Germany, has made for an official visit to that country in May.

The outline of the tour, particulars of which have already been circulated, is as follows :—

Sheffield (or London or other centre)—Harwich—Hook of Holland—Berlin—Weisswasser — Dresden — Karlsruhe — Saarbrucken — St. Ingbert — Wiesbaden — down the Rhine by steamer to Cologne Aachen (three days' meeting with German Society of Glass Technology, civic receptions, works visitation, sight-seeing) — Brussels — Antwerp Harwich and home, departing from England on Friday, May 11, and arriving back, on Saturday, May 26.

Cost of the Tour from Sheffield—£33 10s.

The charge is based on a minimum party of 25 persons.

Cost from London, 18s. 3d. less; from Harwich, £1 11s. 3d. less.

Members resident in the North may find it convenient to travel *via* Seffield so that the advantage may be secured of reduced rates for a party of 25 between Sheffield and Harwich which the fare from Sheffield includes.

The cost provides for third class rail in England, first class on steamers, second class on the Continent, meals en route, hotel accommodation in ordinary first class hotels, together with plain breakfast, table d'hote luncheon and dinner and gratuities in hotels and to catering staffs.

SHORTENED TOURS.

In order to meet the convenience of some members who cannot devote a fortnight to the tour, two variations have been provided.

Variation No. 1.

This provides for members leaving England on Thursday night, May 17, and

proceeding by Antwerp, Brussels and Metz to Saarbrucken, visiting the works at St. Ingbert, then proceeding to Wieshaden and down the Rhine as for the main party, arriving back in England on May 26.

Cost of the Tour: From Sheffield, £21; from London: 18s. 3d. less; from Harwich: £1 11s. 8d. less.

Variation No. 2.

In the case of members who desire to take part in the meetings, sight-seeing and works visits at Aachen, but who cannot join the party on its tour, special arrangements have been made as follows:—

The party will leave London on Monday morning, May 21, at 10.0 a.m., and will travel by Dover and Ostend, arriving at Aachen 10.15 on the Monday evening. Members of this party will join the main party and will arrive back in England on May 26.

Cost of the Tour: From Sheffield: £14 2s. 6d.; from London: £12 5s. 9d.; from London to arrival in Harwich: £11 19s. 3d.

The Secretary will be glad to arrange, at additional charges, for special sleeping accommodation on board the steamers, for air travel across the Channel or to Amsterdam and to obtain, if desired, the necessary passports.

Applications to join the party should be made as early as possible to the Secretary, Society of Glass Technology, Darnall Road, Sheffield.

THE GEOGRAPHICAL ASSOCIATION.

On the occasion of the Spring Meeting at the School of Geography, Oxford, on April 14, Sir Halford Mackinder, chairman of the Imperial Shipping and Imperial Economic Committees, addressed the Association on "The British Empire in Relation to the Geography of the World."

The British Empire, he said, was a coherence of free unities which, they trusted, had arrived at a point at which they had agreed not to fight. His belief was that history, working on the geographical features of the world, had enabled our race, protected as it was from the necessities of military organisation on the Continent of Europe, to render a service to humanity which, as the generations went by, might prove to be supreme. There was no imperialism, in its bad sense, in the desire to see the British Empire sufficiently strong to perform this function in the world.

Dr. N. P. Williams, Lady Margaret Professor of Divinity, preached in the cathedral on April 15 on "Science and the Christian Doctrine of Man." He said that the affirmation of an inherent disproportion between man's elemental instincts and the governing power of reason, which ought ideally to control them, was a fact of experience on which modern analytical psychology had thrown much light. It was true that the idea of primitive revelation could no longer be based on the third chapter of Genesis. But its real foundation remained unaffected by Biblical criticism, because it was consistent with the conviction that an all-wise Creator could not have meant man's nature to be as wayward, ill-balanced, and discordant as we actually saw it to be. Consequently, some deliberate, active intent of declension from the original idea of humanity as it existed in the Creator's mind must be postulated in order to account for the facts of human life as we saw them.

THE PHYSICAL SOCIETY.

The following papers were read at the meeting held on February 24, at the Imperial College of Science, Prof. O. W. Richardson, M.A., D.Sc., F.R.S., in the chair:—

Some Methods of Estimating the Intensities of Spectral Lines. By W. H. J. Childs, Demonstrator in Physics, King's College, London.

Abstract.

This paper presents a critical account of several methods of spectral photometry applied to the special case of the band spectrum of helium. With the method finally adopted, the line spectrum is photographed in the usual way, and the density of the line photographs is measured. For this purpose the plate is calibrated by illuminating the slit of the spectroscope in a special manner by a tungsten filament lamp, so that upon development the plate exhibits a number of images of continuous spectra of progressively increasing density. From these images may be ascertained (*a*) the relation between intensity of light and density of image, and (b) the relation between plate sensitivity and wavelength of the incident light. Density measurements are obtained by a simply constructed selenium cell microphotometer, with which the density contour of each line can be investigated if necessary. Both visual and thermopile microphotometers are also described, and a list of papers dealing with the subject is given.

DISCUSSION.

Mr. J. O. C. Vick asked the Author whether he had tried the method of sharpening the end of the line image obtained with the wedge which consists in contact-printing from the original negative, and again printing if necessary from the copy, the process being repeated as often as may be required. In using the Toy and Rawlings densitometer, how had he controlled the cross- section of the two light pencils to be compared? He might find useful the new design of this apparatus, which employs a photo-electric cell associated with a valve amplified, and is adapted to the photometry of fairly broad spectral lines.

Electrical Methods of Hygrometry. By P. W. BURBIDGE, M.Sc., B.A., Professor of Physics, AND N. S. ALEXANDER, M.Sc., Auckland University College, New Zealand.

ABSTRACT.

An account is given of experiments performed to investigate the possibility of applying electrical methods to the measurement of humidity. Two methods are considered, depending on (1)the change in resistauce of organic materials (cotton-wool and human hair) on exposure to water vapour; (2) the change in mobility of ions due to water vapour.

Results show that in the first case the change in resistance with humidity is not linear, the logarithm of resistance being proportional to the humidity, while in the second the effect produced is too small to permit accurate measurement. Thus, in neither case does the method seem suitable for general use, though each could be applied in special cases.

DISCUSSION.

Prof. A. M. Tyndall : The Author refers to some work done by Mr. Griudley and myself on the effect of water vapour on the mobility of positive ions. This work has recently been carried further, but the results so far obtained are of a complex character and are difficult to interpret. In this connection I should like to ask whether the Author is inclined to attach any significance to the difference in the shape of the two curves IV and V. in Fig. 6, or whether he thinks that the more rapid rise of curve IV is due to accidental causes.

Dr. Ezer Griffiths : The paper is interesting, as it illustrates some of the difficulties encountered when an attempt is made to utilise the electrical properties of a hygroscopic material in the design of a hygrometer. With a loosely packed material such as cotton-wool, imperfect electrical contact of the material with the electrodes is inevitable, and the conduction of electricity under such conditions is complicated by many variables. It would be interesting to know how accurately the line shown in Fig 2 can be reproduced after a period of time. The Authors state that agreement within 2 per cent. is obtained between observations on rising and falling humidities. In a paper by F. P. Slater, published in Proceedings B of the Royal Society, 1924, data are given for the change of electrical conductivity of a single cotton fibre with variations in humidity, and it was stated that equilibrium was not obtained even after the lapse of 24 hours after making a change in the humidity. It would therefore seem that the subject merits further investigation. The Authors refer to the Report of the N.P.L. for 1926, which contains a brief reference to some work on the effect of humidity on the mobility of ions. As this work was carried out by my colleague Mr. Awbery and myself, a few remarks concerning it may be of interest, as we have not yet published a detailed account. At the time we were seeking for a method of measuring fairly rapid changes of humidity, and it was suggested that the variation of mobility of ions with humidity might constitute the basis of a method. Since the relation between humidity and mobility was not then known (the only data available, so far as we knew, being the isolated observation of Zeleny that the mobility of the negative ion in dry air was 1.24 times the mobility of that ion in moist air), our initial efforts were directed to the determination of this relation. We tried the method described by Burbidge and Alexander, but did not find it satisfactory. We employed a thin layer of uranium oxide spread over an aluminium plate and covered by layers of thin aluminium foil, the number of layers being so adjusted that the a rays just emerged and produced an ionised layer of gas close to the plate surface. Whilst there was no difficulty in measuring the small ionisation currents produced, a very formidable difficulty was encountered in the variability of the contact potential effects. With no applied voltage, a small ionisation current was obtained which varied erratically. Changes of temperature of the electrodes had a marked influence. A considerable amount of work was done on the problem, but this simple method of experiment was ultimately abandoned in favour of a wind channel method. The principle employed is well known : the

movement of the ions under the electric field is balanced by an opposing air blast. When moisture is present in the air stream several sources of error have to be guarded against, particularly electrical leakage over the surface of insulators. Zeleny in 1898 tried the air stream method. He employed a current of gas flowing through a tube, the end of which was fitted with a disc of gauze, which very nearly fitted it. He abandoned the method in favour of one in which the electric field on the ions was perpendicular to the air blast. This procedure has been followed by subsequent investigators. By making one modification in Zeleny's original method, we were able to adapt it for the determination of the variation in mobility with humidity. Instead of using a single piece of gauze to close the end of the tube, we divided it up into a central disc and a guard ring. The central disc was made a very accurate fit into the hole in the gauze but was isolated electrically. Now it is a well-known fact that the velocity of the stream in the vicinity of the walls of a tube falls off to zero at the boundary. Consequently, the air-blast method fails if an attempt is made to work with the entire stream flowing through the tube, since there is no opposing blast to balance the electric field in the region of the walls. There is no difficulty in maintaining a constant stream of gas; we employed a small blower, and as indicator of the rate of flow a hollow sphere of glass floating in a conical tube fixed vertically. We found it impossible to blow a sphere with wall of uniform thickness, and this proved to be an advantage. It was observed that when the flowmeter was functioning the sphere would set itself with the thick lenticular segment lowermost. In this position it would ride quite steadily, remaining in the axis of the tube with a clear space all round for the air to flow past. A typical series of observations will be found on page 64 of the N.P.L. Report for 1926.

FORTHCOMING EVENTS.

ROYAL SOCIETY OF ARTS.

John Street, Adelhi.

Monday, April 30, at 8 p.m.—(Dr. Mann Lecture). A. G. Huntley, of the Man Construction Co., Ltd.: "Applied Architectural Acoustics." (Lecture III.).

Wednesday, May 2, at 8 p.m.—William Taylor (of Messrs. Taylor, Taylor and Hobson, Ltd.): "Standardisation in Apparatus for Science Teaching." Hon. Sir Charles A. Parsons, O.M., K.C.B., LL.D., D.Sc., F.R.S., will preside.

SOCIETY OF PUBLIC ANALYSTS.

The next meeting of the Society will be held on Wednesday, May 2, at the Chemical Society's Rooms, Burlington House, Piccadilly, W.1., at 8 p.m. The following papers will be read:—"Locust Kernel Gum and Oil," by A. L. Williams, A.I.C.; "Investigations into the Analytical Chemistry of Tantalum, Niobium and their Mineral Associates. XII. Observations on the Pyrosulphate Hydrolysis Method," by W. R. Schoeller, Ph.D., and E. F. Waterhouse; "A New Precipitation Method for the Determination of Vanadium, and its Application to Steel Analysis," by B. S. Evans, Ph.D., F.I.C., and S. G. Clarke, B.Sc., A.I.C.; "Method for the Analysis of Liquorice Mass," by P. Houseman, Ph.D., F.I.C.

UNIVERSITY COLLEGE.

Gower Street, London, W.C.1.

Monday, April 30, at 5.30 p.m.—"The Making of 'The Times.'" By Sir Roderick Jones, K.B.E. (Chairman of Reuters).

Tuesday, May 1, at 5 p.m.—"The Pharmacological Evidence for Current Methods of Treatment." By Dr. J. H. Burn.

Tuesday, May 1, at 5.30 p.m.—Civilisation in Transit." By Mr. Dixon Ryan Fox, Ph.D.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

9,846.—Brown & Son (Alembic Works), Ltd.—Laboratory apparatus. April 2nd.

10,158.—Coley, H. E.—Manufacture of cyanides from nitrogen. April 4th.

9,947.—Distillers Co., Ltd.—Recovery of acetic acid. April 2nd.

10,206.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of phenol. April 4th.

10,370.—*Soc. Anon. des Charbons Actifs*, E. Urbain.—Preparation of hydrochloric acid, etc. April 5th.

Specifications Published.

263,843.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of thiomorpholines of the anthraquinone series.

287,965.—Osten, Dr. F. W. R., and Grube, E.—Preparation of addition compounds or desoxcycolic acid possessing bacteriocidal properties.

287,995.—*British Dyestuffs Corporation*, Ltd., and Simmons, T. A.—Manufacture of triarylmethane dyes.

285,923.—I. G. Farbenindustrie Akt.-Ges. —Manufacture and production of valuable hydrocarbons or derivatives thereof from coal, tars, mineral oils, and the like.

Abstract Published.

285,488.—Aniline disulphonic acid.—I. G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany.

Aniline-2 : 5-disulphonic acid is prepared by sulphonating aniline-3-sulphonic acid with oleum until the monosulphonic acid has disappeared and subjecting the resulting mixture of di and tri-sulphonic acids to the action of dilute acids. In an example aniline-3-sulphonic acid is stirred into 100 per cent. sulphuric acil, oleum is added and the mixture heated. The sulphonation mixture is then diluted with water and boiled under reflux, or the mixture may be freed from sulphuric acid and boiled with hydrochloric acid, giving a solution containing only the disulphonic acid.

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CONTENTS. PAGE.

Filing Data in the Works 273
By E. S. Kreis, B.Sc., A.R.C.S., A.I.C.
Nova Pictoris 276
By F. H. Loring.
Liver Fluke Disease in Australia 277
By I. Clunies Ross, B.V.Sc.
General Notes:
Heat Saving in Industry 280
Low Temperature Carbonisation 281
Asbestos Paper 282
Standard Atmosphere 282
Speiss and the Metals of the Platinum Group 283
Proceedings & Notices of Societies:—
Geological Society 285
Forthcoming Events 287
New Patents 287
New Trade Marks 288

Obituary.

MRS. GRACE INCHBOULD REA.

It is with the deepest regret we have to record the death of Mrs. Grace Inchbould Rea, wife of Mr. P. M. Rea, Managing Director of the *Chemical News* since 1922. The funeral on April 27th, at the Crematorium, Norwood Cemetery, was largely attended and the floral tributes were numerous. Widespread sympathy has been shewn to Mr. Rea and son on their great sorrow.

FILING DATA IN THE WORKS.

By E. S. KREIS, B.Sc., A.R.C.S., A.I.C.

Few chemists realise the time wasted in looking up data. Fewer still realise the amount of useful information that can be found in technical literature. In these days, busy works chemists cannot possibly read through all the journals and patent specifications connected with their subjects. One day certain data is needed, and a search is made of the abstract journals. This takes a day. The references are then looked up. This takes anything from three days to a fortnight, depending on the importance of the subject and the amount of work published about it. Half these references turn out useless, and of the remaining half, one-third are known to the searcher, and the facts therein recorded already noted.

Big works usually run information services attached to their libraries, yet no works, however small, should neglect this branch. It is often thought that a highly skilled library staff is required: the work should be done by chemists, but in small and medium-sized works, the filing can be done by one of the existing staff, in a very few hours a week.

The success of the information service depends upon the accessibility of the data, and this depends to a very great extent on the system of classification used.

Exponents of decimal and standard systems produce many plausible arguments why all classifications should be standardised. The main argument advanced is that then all chemists would be able to use any library without having to study the system employed. Yet this argument presupposes that some system has already been studied, and that the chemist in question has mastered its intricacies, and has no wish to wade into further classifications! Whatever the merits of the Dewey system, neither British Chemical Abstracts, Chemical Abstracts or the Zentralblatt use it for the classification of their abstracts. Neither the Chemical Society nor the Patent Office Libraries use it for the classification of their books. It is certainly not suitable for an information service.

Perhaps the most obvious thing to do is to take the article—title and classify according to its most significant word. Thus, if an article is entitled "The influence of moisture on the combustion of coal," the article would be relegated to a section "coal," or "fuel." Or, again, the article might be referenced under "combustion." Although logical, a system based on these

lines contains too many loop-holes, and a vast amount of cross-referencing will be necessary. I prefer to file the article under a main heading " Boiler House." This is the obvious place for it. The information is carried straight to the man who wants it : the man in charge of the coal.*

I prefer to classify according to the ultimate destination of the information. Thus, all information relating to the performance of boilers, condensers, and their accessories, will be classified under a main heading "Boiler House," and sub-divided "*Water*," Feed water treatment," " Blow-down," "*Steam*," "*Condensers*"; "*Coal*," "*Gas*," " *Oil*," " Preparation," " Combustion," " Flue-gases," and so on.

In this case " Water " and " Coal," " Gas," " Oil," are main sub-divisions. The three kinds of fuel are unlikely to occur simultaneously in the boiler house. They may be used in different parts of the works, and come under the control of the engineer in charge of the boiler house, but that depends on the individual works, and the classification must also depend on the works. In other words, the classification of the information conforms to the flow sheets.

An analytical section will supply information to the staff of the analytical laboratory. Since they perform coal analyses, all data on this subject will be headed " Analytical." On the other hand, all information about CO_2 recorders, automatic flue-gas analysis apparatus, will go to the boiler house, since these instruments are used there, and not by members of the analytical staff.

An interesting case arose over the classification of the literature for the Association of Chilean Nitrate Producers. The mother-liquors in this industry are only worked for Iodine periodically (Faust, *Ind. Eng. Chem.*, 1926, XVIII, 808). It seemed incongruous to supply literature on Iodine to anybody who was absolutely indifferent to. By relegating all Iodine literature to a section " Iodine," the research staff were spared superfluous information on the solubility of sulphur dioxide, pyrites burners, corrosion by iodine, kinetics of the sulphurous acid—iodine reaction, methods of purification and measurements of the volatility of iodine. The analytical staff still got their information about the estimation of Iodine compounds.

* If the works are concerned in the treatment of coal, another department will need the information, and the section will be different.

This system works well when the sections are chosen with care. No special knowledge of the working of the system is necessary to the person who uses the reference cards. He obviously should know in what stage in the works the substance he is investigating is to be found, or yet again he must know if he is working in the analytical laboratory or in charge of the recrystallisation of sodium sulphate.

One of the existing staff can do all the indexing that is necessary. The greatest expense is incurred in the purchase of journals. Where the works do not subscribe to a particular journal in which there is an article of interest, the odd number of the Journal can be bought, the pages in question can be photographed, or yet a working abstract from a library copy can be made. Photostat copies, reprints, and abstracts should be bound in folders or stout brown paper covers, labelled with their section, and numbered, as they have an uncanny knack of getting lost.

Here is a scheme for the man in charge of the indexing.

(1) Read through the abstract journals, noting any references that may be of value.

(2) Submit the references to the chief chemist, or to the heads of the various departments.

(3) Index the references that have not been rejected.

(4) Procure originals, when required. If these are only obtainable on loan, or can only be seen in a library, take steps to have working abstracts made, for preference by the chemist on the staff who is most capable of dealing with the particular subject.

(5) File abstracts and originals.

Each of the above points needs elaboration :—

(1) Most works subscribe to abstracts " A " and " B " of the Bureau of Chemical Abstracts. These are now very good. Centralblatt abstracts are better, but the subscription is somewhat heavy. (American) Chemical Abstracts are annoying owing to excessive abbreviation. They are sometimes faulty. I believe their field is wider than that of British Chemical Abstracts, but the difference is hardly worth taking into account. Science Abstracts " A " and " B " are very good. I have never had to test their completeness. If these last are not subscribed to, a fortnightly visit to a library where they are kept will probably be sufficient. This remark also applied to the journals following: The Engineering Index

appears yearly, and also monthly, at the end of Mechanical Engineering. References are given, and a few notes. There is no attempt at abstracting. The Institute of Civil Engineers publishes very full and good abstracts of papers appearing in foreign journals. These appear quarterly. I think they should not be missed as they provide a survey of foreign " borderland " literature. They also provide abstracts of certain Swedish and Japanese journals, of articles in which it is expensive to have translations made regularly. Certain specialised journals publish abstracts of articles connected with their special subjects. Kali contains abstracts of articles and patent specifications of interest to the Potash industry, and Caliche to the Chilean Nitrate Industry, The Patent Office publishes abridgments, of British Patents, but they are of doubtful value to the chemist, and it is better to rely on Abstracts " B."

(2) The references should be submitted to the Chief Chemist in the form of short abstracts, or summaries, wherever possible. British Chemical Abstracts are now obtainable printed on one side of the paper only, and if not submitted in this form, the abstracts should be typed to a size convenient for pasting on the back of an index card. The cards should come back marked according to their value. Either " reject," " file," or " obtain further information." Certain abstracts may not be of immediate interest, but are worth filing, since the cost is small. Others require fuller treatment. If the originals are not in the library, and the odd number of the journal is too expensive to buy, it can be dealt with as previously described.

(3) All references should be indexed on cards. Besides the reference, the card should bear on the back a summary of the contents of the article. The printed or typewritten abstract alluded to in (2) can be used, but I prefer to prepare my own summary. This is a more expensive procedure, as reference must be made to the original, in order to prepare the summary. To my mind, every paragraph in the article should have its contents indicated by a word or two, to indicate the derivation of the conclusion by the author, regardless of the " balance " of the whole. Actual data should not be recorded in these summaries, as when this is done, the conditions under which the results were obtained, lose their significance. For this reason reference should always be made to the originals or working abstract.

The card should also bear the call number of the original, if it is in the library, or the number of the folder, if a working abstract has been prepared.

This system works well in practice and involves little outlay either in time or money. It is extremely elastic. So far only published material has been discussed, but it is obvious that the system must include records of the investigations of the works staff. These should be filled and dealt with in exactly the same way as published data. Needless to say, if it is not desirable that there should be free access to such work, a cupboard with a good lock can be provided. It is particularly important that where the investigation is derived from published work, the card bearing the original reference should be connected with the report.

Where several works are run from central offices, the cards should be issued from headquarters, regardless of whether the originals are kept there, or at all or some of the works, which is a matter depending entirely on the funds available and the distances involved.

LABOUR-SAVING MACHINES FOR CHILEAN NITRATE INDUSTRY.

The British Consul at Antofagasta has forwarded some notes on the production of nitrate at a Chilean Oficina in which reference is made to improved and more economical methods of extracting the nitrate salts from the " caliche."
These memoranda will be of interest to firms who are in a position to offer British machinery and plant suitable for any of the operations connected with the production of nitrate, and a copy can be obtained on application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Reference A.X. 6141.)

PATENT OFFICE.

Change of Address at Manchester.

On and from 7 May the Manchester Branch Offices of the Designs and Trade Marks Registries, which at present occupy separate premises, will both be accommodated at the following new address :—

" 51, Regent House, Cannon Street, Manchester."

NOVA PICTORIS.

By F. H. Loring.

The newspapers have given full accounts of the remarkable phenomena occurring in Nova Pictoris, and even theories as to the origin of the breaking up of this star have been touched upon.

This is, of course, a purely astronomical subject, but astronomy of to-day is so blended with physics and physics is so blended with chemistry that those interested in this wider range of subjects represent a very considerable audience.

It is suspected that the asteroids were the result of a series of explosions which took place in a single planet occupying the correct position in the planetary series (see article by the present writer in this Journal of April 13, 1928). If the extreme members of this group are taken, Eros and Hidalgo, their harmonic mean comes out almost exactly to the theoretical value based upon B numbers, the computed value being 20.9 instead of 21. This will be understood by referring to the previous article cited above.

To make matters clear, however, the following table will show how well the B numbers accord with fact. This gives support to the explosion idea in respect of the asteroids.

Planet.	M	M/K	B No.	*Diff.*
Mercury	35950000	3.48	3	− 0.48
Venus	67175750	6.51	7	+ 0.49
Earth	92870000*	9.00	9	0.00
Mars	141505000	13.71	13	− 0.71
Asteroids h.m. 1.46 to 5.71 ast. u.†		20.9	21	+ 0.10
Jupiter	483184000	46.82	45	− 1.82
Saturn	885872000	h.m. = 114.7 (Saturn, Uranus)	119	+ 4.30
Uranus	1782266000			
Neptune	2792665000	270.6	411‡	

M = semi-major axis of orbit in miles.

K = 10319000.

* = astronomical unit in miles.

† = 135432000 and 530287000 miles respectively for Eros and Hidalgo, h.m. being taken. See "Astronomy," vol. I, for basic figures as used in this and the previous article.

‡ = derived from the satellites which follow the regularity rather better on the whole, the largest difference being + 3.19 and the net difference − 1.27. These comparisons are for the B-number range up to 119 inclusive. The two higher numbers average 411 and 805. The net difference in the above table is + 1.88. The dividing constants are adjusted by the distance of the earth from the sun (planets) and the distance of the moon from the earth (satellites).

Now the problem is: What kind of explosion took place in the case of Nova Pictoris? There are at least *four* kinds of explosions.

First, the purely chemical as if the asteroidal planet was largely an explosive compound of nitrogen and mercury and a shower of meteorites set it off.

Second, purely sub-atomic, as the combination of 4 hydrogen atoms (or protons) to form helium, when the slightly excessive mass of addition disappears as radiation according to Jeans' view based upon relativity.

$$4 \times 1.00778 = 4.03112$$
$$\text{Helium} = 4.00216$$
$$0.02896$$

0.029 (mass) being converted into energy of radiation. There is no direct experimental evidence that energy could be evolved in this way, but there is strong theoretical reasons in support of it, in which case the energy liberated would be relatively enormous.

Third, sudden expansion and disruption of matter through impact or near approach of a dark body or other star. From probability considerations this would be a rare occurrence, but there is no evidence, so far, against this being the cause of the phenomenon under discussion.

Fourth, the radioactive atoms suggest by analogy that a star might behave like a radio-atom and eject from its core a part of

of radioactivity, the atom suddenly explodes in part by throwing out an alpha or beta particle. To use Jeans' metaphor, Fate knocks at the door of the atom after a lapse of millions of years, to take a long-period example, and the part explosion takes place. Why is a particular atom selected? And why this seemingly unscientific method of Fate? It is all a mystery, but none the less interesting in consequence. It is tempting to combine 2 and 4, and regard the alpha particle as essentially the summation given above, the difference giving the energy which ejected it. As a parallel some stars may be like radio-atoms as already indicated.

In the case of the star it first appeared *single* then *double* and now it appears to have split into *four parts* with attendant rings. The following from the *Daily Mail* of April 20, 1928, is all the data so far available :—

" Nova Pictoris, the star discovered by Professor Watson, of Beaufort West Observatory, in 1925, is presenting further unusual phenomena.

" It was recently reported that it had split in two, and observations made during the last few days may have an important bearing on astronomical theories as to the cause of that division.

" A series of rings encircling the star has now been observed by the Union Observatory staff at Johannesburg.

" Two theories are entertained to account for the phenomenon. The first is that the rings are caused by waves of light radiating from the star following an explosion, and the second is that they represent matter expelled from the star.

" Dr. Wood, the Union astronomer, estimates that if the first expanation is correct, the star is 6,000 light-years from the earth; if the second, it is possibly only 40 light-years distant.

" The second theory would show that the star was blowing to pieces, and, if it were proved the lapse of time would throw useful light upon the causes of the disintegration of stars.

" According to a Johannesburg (Exchange) message, the latest observations suggest that the star has split into four."

The seat of the explosion may have been either in the star or in the body with which it came into ' contact.'

It is a waste of time speculating as with the variables given above it is easy to construct a plausible theory. It is, however, desirable to have the material set out for consideration, and it is hoped that the above examples will be of interest.

The Times, of April 7, 1928, quotes Prof. A. W. Bickerton's theory as previously known.

In " Astronomy," vol II, p. 760, Jeans' theory of cepheids is given which is suggestive in this connection.

LIVER FLUKE DISEASE IN AUSTRALIA : ITS TREATMENT AND PREVENTION.

By I. Clunies Ross, B.V.Sc.

Veterinary Parasitologist, Council for Scientific & Industrial Research, Australia.

[The great importance of the scientific and industrial research to the whole community is shewn by the following summary of a very practical paper on the Liver Fluke Disease. The circulation of this paper among sheep farmers is calculated (if the advice given be acted upon) to prevent a heavy loss to sheep farmers and indirectly confer a benefit on the community at large. It will be obvious that the Scientific and Industrial Research Department is engaged in a great national work and should therefore be encouraged and supported.—Ed., Chemical News.]

What is Meant by Fluke Disease.

By fluke disease is meant those harmful effects caused by the presence of a flat leaf-like worm, the liver fluke (*Fasciola hepatica* (Linnæus 1758)), in the bile ducts or liver tissue of the sheep or ox. Though cattle are frequently found infested by the liver fluke, the harmful effects caused in these animals are very much less serious than those in sheep. The information given in this pamphlet therefore applies primarily to fluke disease of sheep.

Its Economic Importance and Distribution in Australia.

It is hard to form an accurate estimate of the annual losses in Australia from fluke disease, since these may vary considerably from year to year in each State, and even in each district. It must be remembered also, that there must be included in the losses attributable to fluke infestation not only the actual mortality from this cause, but also the deterioration in the wool and mutton value of those sheep which are attacked but survive. In addition, sheep which are affected by fluke are much more

susceptible to the attacks of other parasites such as stomach and lung worms. It can be definitely stated that over large areas fluke disease is the most serious disease affecting sheep, and throughout the whole of Australia the losses directly attributable to it are not lesss than £100,000 per annum, while in certain years this figure may be considerably exceeded. Fluke disease is of importance in four States of the Commonwealth, namely, New South Wales, Victoria, South Australia, and Tasmania. The areas most seriously affected are those of comparatively high rainfall, and these may occur either in high undulating country such as is found on the tablelands, or in flat, coastal or lake country. Thus in New South Wales the disease occurs throughout the tablelands of the Great Dividing Range, grows less on the western slopes, and disappears on the plains. In Victoria, it is met with principally in the Gippsland district, parts of the Western and central districts, and particularly along the valley of the Goulburn River. In South Australia, losses are confined to the wet South-eastern part of the State, while in Tasmania severe losses occur on the flat coastal areas of the North-east, the valley of the South Esk River, and in some of the river and irrigated land of the Midland Division. In Queensland fluke disease in sheep is very rarely seen, while it is practically non-existent in Western Australia.

That this disease, which is to a very large extent preventible, should continue to exact its toll is lamentable. Every stock-owner has his part to play in its eradication, and this pamphlet has been prepared with the object of assisting individual owners to do their utmost in that connection.

THE LIFE-CYCLE OF THE FLUKE PARASITE.

In order that the pastoralist may appreciate how fluke disease is spread and how it may be prevented, it is essential that he should understand the life-cycle of the parasite which causes the disease.

The adult parasite is a flat, yellowish or greenish-brown worm, leaf-life in shape, and about 1 inch long by ½ inch wide. In a fluky liver the parasite may be readily demonstrated in the bile ducts. Here the worm lays its eggs, and each fluke may produce many thousands of eggs, which are minute yellowish-brown objects of the typical egg shape, and may be seen by smearing some of the bile from the ducts on a glass slide and then holding it up to the light. After leaving the liver the eggs mingle with the bowel contents, and so pass out of the sheep on to the pastures. Development now commences, but soon ceases unless the eggs have fallen into water or some moist place, for if the eggs become dry they soon shrivel up and die since it is only in water that they are able to undergo further development. On reaching water, development proceeds rapidly, and in eleven days in summer weather but much longer in cold weather, a minute embryo fluke is formed within the egg. The embryo now commences to make active movements so that a cap at the end of the egg is pushed up, and the little fluke, which is of microscopic size only, emerges and swims about rapidly by means of the fine hair-like processes with which it is covered. This little fluke, (*miracidium*) can only live for a few hours unless it meets with a certain variety of fresh-water snail in which it is to undergo further development. A particular Australian snail in which this development commonly occurs will be described later. Having found its snail, the fluke bores its way into it and then passes to the internal organs, where it commences a complicated course of development. After some months, growth within the snail is completed, and from each original young fluke (*miracidium*) which entered the snail more than a hundred new individuals may have been formed. These new young flukes are still of little more than microscopic size, but are heart-shaped with long tails. They now make their way out of the snails and swim about in the water for a short time, and then attach themselves to blades of grass or weeds. Their tails drop off, and a secretion is thrown out which forms a protective covering or cyst wall around them. These young encysted fluke (*cercariæ*) are the final stage passed outside the sheep, and they are now ready to infest the sheep. How is this brought about? Simply by sheep (or other stock) swallowing the young fluke, while grazing over marshy areas or on weeds growing at the side of streams and creeks. Some young fluke, instead of attaching to grass may float, surrounded by their protective coat, on the surface of the water, and though this is a much less important method of infestation, stock may become infested in this way as they drink from snail-infested pools. *It is only by swallowing the young fluke which have left the snails and have attached to grass or are floating on the water that sheep become infested with fluke.* Having been swallowed, the protective coat surrounding the fluke is dissolved by the digestive juices and the fluke bores its way into the wall of

the bowel. Passing through the bowel it falls into the abdominal cavity. Here it wanders about for some days growing in size till it is about an eighth of an inch long, and resembles the adult fluke in shape. At the end of this period it makes its way to the liver, bores into the surface of the organ, and then passes to the bile ducts. Here it becomes mature, and produces eggs eight weeks later.

It is especially important to remember in connection with the above life-cycle that—

(i) Fluke eggs can develop and hatch only in water.

(ii) The young fluke die unless they find certain fresh-water snails.

(iii) Stock become infested only by grazing on herbage to which fluke have attached themselves after passing out of the snail; or by drinking water on which the young fluke are floating.

Thus it will be seen that the two all-important factors in the spread of fluke disease are water and snails, and without these the disease cannot continue.

HOW AND WHERE FLUKE DISEASE IS SPREAD.

We have seen that snails are necessary for fluke development, but not all snails will serve this purpose. It is desirable that the dangerous varieties should be recognised. The common fresh-water snails met with in Australia are of two types, which may be distinguished as follows. Place the snails with the opening of the shell downwards, and with the point of the shell towards you. It will be seen that in one type the basal coil of the snail when traced downwards curves to the right, in the other to the left. Those snails in which the curve is to the right belong to the dangerous group.

Distribution of Fluke Snails.—The snails are widely distributed and may occur in a variety of situations. They are perhaps most commonly found in shallow marshy areas, such as those spreading out from springs and along the beds of slow-running streams. They may also be found in the spring itself, and in shallow rocky pools, and even in clear running streams or fast flowing rivers. The snails occasionally exist in areas where losses from fluke are unknown, as, for example, in the bore drains or the dry north-western plains of New South Wales. Both the dangerous and the unimportant varieties of snail frequently occupy the same situations, but the latter are perhaps most frequent in the larger pools and small lakes.

It is in certain definite situations that the presence of the fluke snail is most dangerous, and these are those marshy areas which, while containing sufficient water for snail life, are yet so shallow that sheep are able to graze over them. It will be seen that young fluke leaving snails in these situations are easily able to attach themselves to grass, etc., from which position they can readily infest sheep. On any property where losses from fluke are met with, the owner will almost certainly be able to recognise some spot having these characteristics and probably will have associated it with fluke. Where snails occur in clear streams with well defined banks, or in the deeper pools the banks of which are free from weeds or grass, the danger is greatly diminished for the following reasons. Firstly, there is much less chance of sheep's dung containing fluke eggs falling into water and of the fluke eggs hatching, so that the danger of snails becoming infested is proportionately less. Secondly, the young fluke emerging from any snails which do become infested are less likely to become attached to weeds or grass eaten by sheep. This will explain why in some cases, though many snails have been noticed in such pools or streams, yet heavy losses in these paddocks have not been experienced, while in other paddocks where snails are hard to find losses have been serious. In one place conditions are unfavourable to the infestation of snails and sheep, in the other everything predisposes towardls it.

Why losses from fluke fluctuate from year to year.—It will have been noticed that losses from fluke are subject to considerable variation, but that they tend to be worst after one or two abnormally wet years. It will be readily appreciated that in such years the area of marsh and bog land increases, and new springs break out, so that everything conduces to the hatching of fluke eggs and the spread of infected snails. The latter therefore increase in numbers enormously

Though in general wet years are responsible for the heaviest losses from fluke, yet in those parts where losses are fairly constant, dry weather may to some extent predispose towards infestation in certain paddocks. This is due to the fact that in long periods of dry weather, perhaps the only green area in a paddock will be found surrounding a spring or along the course of a stream which almost certainly contains snails. In such a paddock, all the sheep will often be found congregated along this green area, and as long as it remains damp and marshy the chances of sheep becoming in-

fected will be very great, since they are thus forced into the very place where infected snails and, therefore, young fluke are most concentrated.

THE TREATMENT OF FLUKE DISEASE.
CARBON TETRACHLORIDE.

In treating sheep for liver fluke, it has been found that most of the drugs usually employed against other internal parasites of sheep, such as the stomach worm, are quite ineffective. One drug, however, has recently been found to surpass all others in efficiency against fluke. This drug—carbon tetrachloride—is a heavy colourless liquid, having a characteristic aromatic odour. In its properties it is related to chloroform, and if inhaled, it has a similar anæsthetic action. It may be conveniently administered and its cost is relatively small.

Dose of carbon tetrachloride.—The dose of carbon tetrachloride which has been found completely effective against fluke is very small, being only 1 cubic centimetre, or in other words about 16 drops. This quantity may be given with safety since it has been found that some sheep will tolerate a dose 80 times as large. There is, however, no good purpose served in increasing the dose, and in some cases there may be a small degree of danger if this be done. Owing to the smallness of the dose, it is necessary to give the drug in such a way that none of it is lost.

Methods of administering the drug.—(i) *In solution, by means of a syringe.* By this method carbon tetrachloride is first diluted to form a larger dose with some suitable substance, and is then given by the mouth by means of a syringe. The most suitable substance for mixing with carbon tetrachloride is liquid paraffin—a colourless oily liquid with which it readily mixes to form a mobile fluid which may be easily given. Four parts of liquid paraffin should be mixed with one part of carbon tetrachloride. The dose of carbon tetrachloride is 1 cubic centimetre (16 drops) so that this must be mixed with 4 cubic centimetres of liquid paraffin to form a total dose of 5 cubic centimetres. It is useless to try and dilute the drug with water since the two will not mix, while the practice of mixing it with kerosene is to be condemned, since it may be dangerous to sheep.The dose can be administered by using an ordinary hypodermic syringe (without the needle and of 5 c.c. size), which when filled will contain the correct amount. Certain commercial firms prepare a mixture of the two ingredients in the proper proportions ready to administer, and supply special syinges made to hold the required dose. If the mixture is prepared by the sheep owner, he should take care to secure ony chemically pure carbon tetrachloride from reliable wholesale chemists, and the drug should be mixed only with liquid paraffin as above described.

(ii) *Giving carbon tetrachloride in capsules.*—Carbon tetrachloride may also be conveniently given in small gelatine containers or capsules. These are of two kinds, *viz.*, (a) soft elastic capsules, and (a) hard gelatine capsules.

(a) Soft elastic capsules ready filled with the required dose (1 c.c.) of carbon tetrachloride are prepared by certain firms. By giving the drug in this way there is no danger of evaporation or leakage, and the correct dosage is guaranteed.

(b) Hard gelatine capsules are supplied empty and must be filled before use. When ordering these capsules ask for empty gelatine capsules of the size to hold 1 cubic centimetre. No measuring of the drug is then necessary, the bottom half of the capsules when filled containing the proper dose. Capsules should be filled shortly before use, and this is best done by two assistants holding, opening, and closing the capsules as they are filled by a third person.

(To be Continued.)

GENERAL NOTES.

HEAT SAVING IN INDUSTRY.

The use of waste heat from flue gases is rapidly becoming an important factor in industrial economy, and its significance is clearly seen in reduced fuel bills. The economiser has already demonstrated the value of otherwise waste heat, when it is transferred to the boiler feed water in steam-raising practice, while the air heater, by taking waste heat from the flue gases and transferring it to the air required for burning the fuel, has also shown notable increases in combustion efficiency.

One distinctive feature of pre-heated air in fuel burning is the increased heating effect of the combustion process by intensifying the radiant heat of the furnace. Also, the combustion process is made more nearly complete and the percentage reduced, with resultant economy. It has been estimated that for each 20° to 30° F. increase in the temperature of air passing into the furnace a coal economy of 1 per cent. is secured. This explains the remarkable reductions in fuel consumption for the same steam out-

put which have been secured with some installations.

The practice of pre-heating the air has become a recognised feature of modern power-plant practice, as instance the Howden-Ljungstrom pre-heaters which are being installed at the new power plant for Synthetic Ammonia and Nitrates, Ltd., at Billingham. In this case the pre-heaters will have an efficiency of slightly over 68 per cent. and the temperature of the air will be 500° at normal load and 520° at mixïmum load, the entering gas temperatures heing 600° and 640° respectively.

The Shanghai Municipal Council installed four Howden-Ljungstrom regenerative type pre-heaters in 1926, and as the result of this satisfactory performance have since ordered one for a new Stirling boiler fired with pulverised fuel which is being put in this year, and two further pre-heaters for two 100,000 lbs/hr. boilers in the original boiler house.

Hull Corporation Electricity Department have also decided to instal this type of preheater in connection with five new boilers now on order, this being the third repeat order from the Hull Corporation.

LOW TEMPERATURE CARBONISATION FUEL.

Gas and Electricty Companies as Potential Consumers.

Th largest potential consumers of the products of low temperature carbonisation are the gas and electricity undertakings. This was the view put forward by Mr. R. P. Wilson, C.B.E. (past president) and Mr. C. H. Parker (son of the inventor of the Coalite process of coal distillation) in a joint paper read on Friday, April 13, to the Institution of Engineering Inspection at the Royal Society of Arts.

"The technical staffs of the big gas companies know their business very thoroughly" continued the authors, and as the Gas Light and Coke Company have embarked on the construction of two low temperature carbonisation processes in collaboration with the Fuel Research Board, it may be hoped that in the near future a great deal of very valuable and reliable information will be forthcoming as to the results which may be expected from a combination of low and high temperature carbonisation.

Possibilities in Industry.

"It sounds like heresy to suggest the possibility of a change over from high temperature to low temperature, but it will surely be taken into consideration, and will certainly not be condemned without exhaustive research and irrefutable evidence of its shortcomings. Low temperature carbonisation offers possibilities to all industrial undertakings which are large coal consumers, in the direction of fuel economy—possibilities which are too promising to be neglected."

"If," they added, "the gas companies had carried out their emphatic statement made many years ago when coalite was first produced, that they could make an exactly similar product, committees on smoke abatement would never have been called into existence."

Dealing with the future of coalite as a domestic fuel, the authors said that a great deal of abuse had been hurled at the open domestic grate, and no douht much of it was well-deserved, but it might be said, without fear of contradiction, that the well-designed domestic grate. burning the right kind of smokeless fuel, was still and apparently always would be the most satisfactory and healthy, as well as the most comfortable means of heating an ordinary living-room. Anthracite contained about 84 per cent. of pure carbon, and coalite contained very nearly the same amount. The volatile content of domestic fuel turned out by low temperature carbonisation processes was from 6 to 8 per cent. There was no virtue in leaving a greater volatile content in the fuel, but it was necessary to leave about that amount, because otherwise the fuel was equivalent to gas coke, which would not ignite.

In the course of the discussion, Colonel Bristow, referring to the low temperature carbonisation plant in operation at Barugh, said that at present there were four batteries working, and one in reserve; the four batteries distilled 1.500 tons of coal per week, and produced about 1,000 tons of coalite, as well as other products, such as coal oil, motor spirit and gas. That coalite was sent to practically every large city in the country. Coalite was sold to the public in this country to-day at the same price as good house coal.

WASTE GASES OF THE RUHR TO BE UTILISED.

Capital for an important new German synthetic nitrate enterprise, which will utilise coke oven gas for the manufacture of a wide range of fertilisers, is to be raised

auspices of Dillon Read & Company, the well-known American bankers. The new company, which is called the Ruhr Chemical Products Corporation, has been formed by a consortium of 27 of the leading coal and coke companies of the Ruhr, headed by the Vereinigte Stahlwerke A.G. (United Steel Works Corporation), and large plants capable of an annual production of 300,000 tons of synthetic nitrate, compared with a total world production of 695,000 tons, are at present in course of construction. The principal plant at Holton near the Rhine will, it is understood, be in operation early next year, and nine months later a second unit is to be started, to be followed later by several others.

The processes used will be the Concordia-Linde and the Casale processes for the production respectively of hydrogen and synthetic ammonia. These processes are stated to be a formidable rival of the Haber-Bosch process used by the I.G. Farbenindustrie. The present surplus of coke oven gas in the Ruhr is estimated at over 9,000 million cubic metres annually, which, if fully utilised, is equivalent to an annual production of 1,800,000 tons of synthetic nitrate, *i.e.*, three times Germany's present output. Other important coke oven gas derivatives include a methyl petrol substitute, and it is intended to produce this on a large scale.

The principal output of the new combine will be a range of fertilisers similar to the Nitrophoska fertilisers of the I.G. Farbenindustrie, and the possibility exists of a groups. Marketing of the new fertilisers of the Ruhr Chemical Products Corporation, however, will be through the Synthetic Nitrate Syndicate, the corporation which markets for the I. G. Farbenindustrie, and this is regarded as indicative of an attitude of co-operation rather than competition between the two combines.

ASBESTOS PAPER AND ASBESTOS MILLBOARD.

(*U.S.A. Bureau of Standards.*)

Asbestos was practically unknown to the scientific world of less than a century ago. It has not been in commercial use much over 50 years. Nevertheless, its many uses have become so well established that to-day the manufacture of asbestos products is an industry of very great consequence.

The increasing importance of this commodity to modern engineering and mechanical practice, as well as to the efficient con- [illegible] whatever heat insu- marks it as an important index of progressive efficiency in the conservation of energy and elimination of waste in the national economy.

The United States ranks first in importance in the manufacture of asbestos products, drawing its supply of raw materials mainly from Canada and South Africa. The average annual consumption of crude asbestos in the United States—that is, production plus imports, for the five-year period 1920 to 1924—was 161,225 short tons. The estimated annual world production for the same period was 187,245 tons. Consequently, the United States may be said to consume 86 per cent. of the world's production. Domestic production is only one- third of 1 per cent. of world production.

The total quantity sold or used by producers in the United States in 1926 was 1,358 short tons, valued at $184,731, according to figures compiled by the United States Bureau of Mines, Department of Commerce, from individual reports furnished by producers. These figures represent chrysotile asbestos mined in Arizona and amphibole asbestos mined in Georgia and Maryland. The sales of chrysotile asbestos were much larger both in quantity and value than those of 1925, and the sales of amphibole asbestos showed a decrease in quantity but an increase in value.

Imports of unmanufactured asbestos for consumption amounted in 1926 to 257,621 short tons, values at $8,142,505, and the exports were 1,104 short tons, valued at $85,922. Corresponding figures for 1925 were: Imports, 280,520 tons, valued at $7,184,302; exports, 1,109 tons, valued at $70,846.

Because of the number of its possible uses, this commodity affords a fertile field for diversification of sizes, grades, and weights. This is especially so in the case of asbestos paper and millboard. It is therefore particularly fortunate that the industry has had the foresight to restrict its production to the fewest standards which will meet the requirements of the consuming trade. This action should prevent much of the waste which has existed in some of the older industries.

STANDARD ATMOSPHERE.

By W. G. Brombacher, Physicist.

(*U.S.A. Bureau of Standards.*)

In aeronautics a standard atmosphere is an assumed condition of the atmosphere which is defined by an altitude-temperature-

among the various atmospheres which have been proposed lies in the selection of the altitude-temperature relation. A standard atmosphere is an aeronautic necessity in evaluating the performance of airplanes and for the calibration of instruments. For example, the performance of an airplane, such at its rate of climb or ceiling, in order to be comparable with that of other machines is stated in terms of altitudes which correspond to the same standard conditions of air temperature, pressure, and density. Further, altimeters are pressure-measuring instruments graduated in terms of altitude according to the altitude-pressure relation of a standard atmosphere. Air-speed indicators are calibrated to indicate true air speed at a standard air density. The results of wind-tunnel investigations are also reduced to a standard density of air.

A standard atmosphere has been officially adopted for use in the United States for the above and other aeronautic purposes by the following Government organisations: Army Air Corps, Bureau of Standards, National Advisory Committee for Aeronautics, Navy Bureau of Aeronautics, and the Weather Bureau. This atmosphere is now in general use throughout the United States in aeronautics except in the evaluation of the altitude of flights made to break international records, in which case the Fédération Aéronautique Internationale standard atmosphere is the basis of comparison. The altitude-temperature assumption of the United States standard is a slight modification of that proposed by Toussaint and closely approximates the average observed values of air temperature at all altitudes at latitude 40° in the United States.

The formulas defining the United States standard atmosphere are given below.

(*a*) For all standard altitudes

$$Z=K\frac{T_m}{T_0}\log_{10}\frac{p_0}{p} \qquad (1)$$

$$\rho=\rho_0\frac{p}{p_0}\,\frac{T_0}{T} \qquad (2)$$

$T_0 = 288°$ absolute $= 15°$ C.

$p_0 = 760$ mm of Hg $= 29.921$ in. of Hg.

$K = 19,418.3$ for Z in meters.

$= 63,691.8$ for Z in feet.

$\rho_0 = 1.2255$ for ρ in kg/m³.

$= 0.07651$ for ρ in lbs./ft.³

(*b*) Up to the isothermal layer (below 10,769 m)

$$T_m=\frac{aZ}{\log_e\dfrac{T_0}{T_0-aZ}} \qquad (4)$$

$a = 0.0065000$ for Z in meters.

$= 0.0019812$ for Z in feet.

(*c*) At the lower limit of the isothermal layer (10,769 m)

$T = 218°$ absolute $= -55°$ C.

$Z_{55} = 35,332$ feet $= 10,769$ meters.

$T_{m55} = 251.878°$ absolute.

(*d*) In the isothermal layer (above 10,769 m)

$T = 218°$ absolute $= -55°$ C.

$$T_m=\frac{Z}{\dfrac{Z_{55}}{T_{m55}}+\dfrac{Z-Z_{55}}{218}} \qquad (5)$$

In the above formulas

Z = Standard altitude.

Z_{55} = Altitude at the lower limit of the isothermal layer.

Z = Absolute temperature of the air at altitude Z.

T_0 = Standard sea-level temperature in degrees absolute.

T_m = Mean temperature of the air column below altitude Z in degrees absolute.

T_{m55} = Mean temperature in degrees absolute for Z_{55}.

p = Pressure of the air at altitude Z.

p_0 = Standard sea-level pressure.

= Density of the air at altitude Z.

ρ = Density of the air at altitude Z.

ρ_0 = Standard density at sea level.

Absolute temperatures are equal to centigrade temperatures plus 273. p is in the same unit of pressure as p_0.

SPEISS AND THE METALS OF THE PLATINUM GROUP.

By H. Rusden and J. Henderson.

(*Before the Chemical, Metallurgical and Mining Society of South Africa.*)

Some of our members on seeing the title of this paper might ask the following questions:— First, what is speiss? Second, what is its connection with the platinum metals?

The essential constituent of a speiss is arsenic or antimony. In the speiss produced at the Witwatersrand Co-operative Smelting Works By-Products Branch the

chiefly with iron. There are also present considerable proportions of copper and nickel with small quantities of lead and sulphur, as the following average analysis of several lots of speiss shows :—

Arsenic	19.5
Iron	56.0
Copper	8.1
Nickel	8.5
Lead	3.3
Sulphur	4.1
Insoluble residue	0.7
	100.2

Speiss is produced in pan furnace and lead blast furnace operations when arsenic is present in the charges. Its specific gravity is such that if a molten mixture of lead, speiss, matte, and slag were run into a mould, the four materials would solidify in distinct layers, lead on the bottom, then speiss, then matte, and finally slag. The junction between each layer is sharp and decided, and as a rule, the various materials can be readily separated. In appearance speiss is white and metallic, very similar to white cast iron, and rusts on exposure to the atmosphere. It is hard and brittle, but can be crushed to powder in a crushing mortar. Were it not for its remarkable affinity for the metals of the platinum group, it could not be considered as a desirable product of furnace operations, particularly in the case of lead blast furnaces working for the extraction of gold and silver. Its presence tends to form obstructions in the crucible of the furnace known as "horses."

But its marvellous property of acting as a collector for platinum metals at once raises it to a position of great importance and intense interest. What its maximum absorption figure is has not yet been determined, but on a small experimental scale we have made a speiss containing 6.9 per cent. of the platinum metals equal to 2,012 oz. per ton. Previous to 1923 no attempts had been made to dispose of any speiss produced at the smelting works, but from that time onwards many lots of one ton each were despatched overseas with satisfactory financial results, particularly when the price for osmiridium concentrates was £30 per oz.

RECOVERY OF DEBTS IN TURKEY.

The British Commercial Secretary at Constantinople has forwarded a translation of a Law, dated 15 March, 1928, which was published in the Official Journal of 21 March supplements existing Turkish legislation in regard to the recovery of debts. The provisions of this Law are of some importance, as they are of direct assistance to creditors in taking action against debtors in Turkey.

In the first instance the creditor can obtain an injunction against his debtor from the "Bureau Exécutif" without the necessity of bringing an action and obtaining an injunction from the Courts themselves. The creditor will thus be able to take legal proceedings without delay and expense.

Upon receipt of a notification from the Executive Office, the debtor is obliged to meet his obligation within a maximum period of 15 days, though he, of course, retains the right to deny the existence of the debt, or, alternatively, to dispute the amount claimed.

The creditor is protected against frivolous protests on the part of the debtor by the provisions of the last two paragraphs of Article 1, which prescribe that, in cases where the protest is not upheld by the Court, the debtor shall be condemned to pay, in addition to his debt, an indemnity of not less than 10 per cent. of the amount claimed.

CALIBRATION AND ADJUSTMENT OF THE SCHOPPER FOLDING TESTER.

By F. T. Carson and L. W. Snyder.
(*U.S.A. Bureau of Standards.*)

The Schopper folding tester, which is designed to test the bending endurance of paper and its resistance to such types of wear as involve creasing and folding, is so constructed that a number of mechanical variables are introduced by reason of the several rollers and other working parts which are driven by the specimen being tested. These mechanical variables affect the folding results in much the same manner as do errors in adjusting the tension applied to the specimen during the test, and apparently can in general be expressed as equivalent effective tension. The tension on the specimen is very critical, the effect on the folding results being inversely proportional to something like the tenth power of the tension, according to available data.

Owing to the necessity of frequent confirmation of the amount of applied tension, devices have been developed for facilitating the adjustment. A new device is described which permits calibration and adjustment of the springs without disturbing the assembly of the tester. This is a balanced bell-crank lever supported by a knife-edge in such

against dead weight with a minimum of inconvenience.

A method is outlined for measuring the friction of the rollers and an effort is made to emphasise the magnitude of this influence upon the folding results.

CANADIAN BUILDING PERMITS START YEAR AT RECORD LEVEL.

The value of building permits issued in 63 cities in Canada during February was the highest for that month in the record, which goes back to 1900. The total for the month under review was $10,323,405, compared with $7,712,604 in January, 1928, and $7,638,176 in February, 1927, gains of 33.9 and 35.2 per cent.

CANADA'S FIVE BIG CROPS IN SIX YEARS.

The official estimate of the value of Canadian field crops in 1927 is given at $1,134 million compared with $1,105 million in 1926, an increase of 2.5 per cent. "The value of the field crops of last year exceeds that of any other harvested in the Dominion, except in the period from 1917 to 1920, when prices were inflated through war conditions," states a report by the Canadian Government Bureau of Statistics. As far as physical volume is concerned, Canada has been favoured with five bountiful crops in the last six years, the crop of 1924 being the only exception during the period.

CORRESPONDENCE.

SUN OR MOON FOR WORKERS?

(*To the Editor of the* CHEMICAL NEWS.)

13, Greville Place,
London, N.W.6.

Dear Sir,

Much public attention is now being directed to the highly successful demonstration in the pithead clinic at the Sherwood Colliery, Mansfield, or artificial sunlight baths for miners.

This very practical step towards fostering the right spirit in industry has aroused the sympathetic interest of men as different as the Duke of York and Mr. Cook.

An experience, which has just been brought to my notice, of the industrial value above ground of complete real sunlight is therefore interesting at the moment. Last March Messrs. Ferranti's equipped a large extension of their electrical and general engineering works at Hollinwood in Lancashire with 33,000 square feet of vitaglass admitting the ultra-violet as well as all the other rays of the sun direct to the workers at their benches, and they have now had an opportunity of noting the effects.

The particular shop is declared to be notably brighter and warmer, its occupants are manifestly content and happy. In short, it has been found that the experiment gives all the advantages of sunlight indoors.

Who will put a limit to the results in a generation's time of these efforts to bring the real sun to workers within its reach and to create artificial sunlight for those who toil where windows are not?

A worker who is given the sun will not cry for the moon.

Yours faithfully,
C. W. SALEEBY,
M.D., F.Z.S., F.R.S.E.

Proceedings and Notices of Societies.

GEOLOGICAL SOCIETY.

The following communication was read at the meeting held on February 22, 1928—

The Pre-Cambrian Complex and Associated Rocks of South-Western Lleyn (Carnarvonshire). By CHARLES ALFRED MATLEY, D.Sc., F.G.S. With a Chapter on the Petrology of the Complex, by Edward Greenly, D.Sc., F.G.S.

The pre-Cambrian Complex of Lleyn occupies the costal strip from Nevin to Aberdaron and Bardsey Island, the geology of which was described by the Author in 1913, and is a detached 'region' (the Mainland Region) of the Mona Complex of Anglesey. Its age is definitely pre-Cambrian, and its special structures and metamorphism were impressed on it before Cambrian times. It is bounded on the east by a great thrust which has driven it over Ordovician strata and the Sarn granite.

Its members are now correlated with those of Anglesey. The Gneisses, several

members of the Bedded Succession, the Plutonic Instrusions, and the ' Penmynydd Zone of Metamorphism ' are all represented. The Holyhead Group is absent.

The Gneisses are always found near the boundary-thrust. Both their basic and their acid members are almost identical with those of Anglesey. Their crystallisation and foliation are older than the deposition of the Bedded Succession.

Most of the region is occupied by the Gwna Group. On a low horizon of this are the laminated Abergeirch Phyllites, above which come alternating grit and phyllite, quartzites, and limestones. There is a strong development of ellipsoidal spilitic lavas, with tuffs, limestone, and jasper, and sills of albite-dolerite. All members of the group, except the Abergeirch Phyllites, are mostly in the condition of a schistose autoclastic mélange. Part of the group is in the anamorphic condition known in Anglesey as the Penmynydd Zone of Metamorphism, being now mica-schists, some of which may, however, be metamorphosed Fydlyn Beds.

Resting on the Gwna Beds are some 300 feet of quartz-albite dust-rocks (Gwyddel Beds). They may be a special facies of the Skerries Group of Anglesey, with a representative of the Tyfry Beds at their base.

The gabbros are akin to those of Anglesey, and are regarded as plutonic intrusions belonging to the Complex.

The tectonics and foliation of the Complex resemble in almost every detail those of the Complex in Anglesey. On the working hypothesis of recumbent folding adopted for Anglesey, Dr. Greenly is inclined to regard the Mainland Region as the lower uninverted limb of a recumbent fold (a Lleyn Fold) belonging to a higher tectonic horizon than those now found in Anglesey.

The Arenig rocks at Aberdaron form a faulted syncline overridden on the west and north by the Complex, and faulted against it on the east. They probably occur as a ' window.' About 1,000 feet of sediments belonging to the *D.-extensus* Zone and 200 feet of *D.-hirundo* Beds are exposed. They contain a thick sill of albite-dolerite, which transgresses a zone of fine-textured pyroclastic cherts containing abundant sponge-spicules.

Many basic dykes are exposed in the Complex, of which the great majority are Palæozoic (post-Llandovery and probably post-Silurian), but earlier than the great thrusting movements which took place after the close of Silurian time. Three Tertiary dykes have been found.

Many thrusts and shear-planes later than the Complex are found in the Complex itself, cutting across the foliation and the autoclastic mélange, and disrupting the Palæozoic dykes. They were produced by minor movements during the general movement which drove the Complex of Lleyn over the Ordovician strata. The boundary-thrust is certainly a great rupture, which shows no sign of dying out at either end of the exposed part of the Complex. The extent of its overdrive cannot be determined, but it should probably be measured in terms of miles, and may have been sufficient to sever the whole plexus of Palæozoic dykes in the Complex from their roots.

Dr. Greenly compared the petrological characters of the several members of the succession in the Mona Complex with those found in Anglesey, showing that the correspondence, despite the distance, is singularly close. The Gwna Beds belong to the eastern facies. The fact that, despite the cover of Drifts and of frequent decomposition, the Acid Gneisses had been detected, was due to the minute mapping of Dr. Matley.

This region of the Complex does not appear to correspond to any of the region of Anglesey, and its prolongation is more likely to be buried beneath the Palæozoic formations between Bangor and the mountains.

The theory of recumbent folding has justified itself by furnishing consistent explanations of a number of anomalies, but ought not to be regarded as more than a good working hypothesis. The complexities of the visible structure are astonishing; and the speaker often wondered whether the key to these wonderful regions of crystalline schists might, after all, prove to be some principle whereof we have at present no idea whatever.

Discussion.

The President referred to former controversies in the adjacent areas as to the existence of pre-Cambrian rocks which are now definitely established. The Author's work throws an interesting light on the problems of the older rocks of Scotland, as along the southern border of the Highlands a series of Arenig beds with cherts and graptolitic shales have been overthrust, as held by Mr. G. Barrow, by a series of rocks which have many resemblances to the Gwna Group of Anglesey and the Lleyn. The area described by the Author has the advantage over the Scottish area that the foliation and other structures in the rocks are proved to have been impressed on them in pre-Cambrian times.

FORTHCOMING EVENTS.

GEOLOGICAL SOCIETY OF LONDON.

Wednesday, May 9.—" The Geology of the District around Meifod (Montgomeryshire." By William Bernard Robinson King, O.B.E., M.A. F.G.S.

INSTITUTION OF MINING AND METALLURGY.

225, City Road, London, E.C.1.

Tuesday, May 8 at 7.45 p.m.—Annual Dinner at The Hotel Cecil.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

At the House of the Royal Society of Arts, John Street, Adelphi, W.C.2.

Tuesday, May 8, at 5.30 p.m.—" Experiments in Viscometry." By H. S. Rowell, O.B.E., F.Inst.P., M.I.Mech.E., and D. Finlayson.

OIL AND COLOURMEN'S ASSOCIATION.

Thursday, May 10, at 8 St. Martin's Place, Trafalgar Square.—Annual General Meeting. — Demonstration of Analytical Quartz Lamp. H. Hepworth, D.Sc., F.I.C. : " Nitrocellulose Lacquers."

ROYAL INSTITUTION.

21, Albemarle Street, London, W.

Thursday, May 10, at 9 p.m.—Miss Doris L. Mackinnon, D.Sc., Professor of Zoology, University of London, King's College : " Life's Unsuspected Partnerships."

ROYAL SOCIETY OF ARTS.

John Street, Adelphi, London.

Wednesday, May 9, at 8 p.m.—" The Sterilisation of Milk." By Captain Reginald Willington Lane. Professor R. Stenhouse Williams, M.B., C.M., B.Sc., D.P.H. (Research Professor in Dairy Bacteriology, University College, Reading), will preside.

THE INSTITUTE OF METALS.

The Eighteenth Annual May Lecture to the Institute will be delivered by Professor Cecil H. Desch, F.R.S., on " The Chemical Properties of Crystals," at the Institution of Mechanical Engineers, Westminster, S.W.1., on Tuesday, May 8.

UNIVERSITY OF LONDON.

University College, Gower Street, London, W.C.1.

Monday, May 7, at 2 p.m.—" Two Ancient Love Stories in Epic." A public lecture by Prof. W. P. Butler.

At 5 p.m.—" Ruskin's Theory of Art." First of a course of three public lectures, by Prof. G. Dawes Hicks, F.B.A. (May 7, 14, and 21.)

Also at 5 p.m.—" Anatomy and the Problem Behaviour." First of a course of three lectures by G. E. Coghill.

Tuesday, May 8, at 5.30 p.m.—" Dante Gabriel Rosetti." A public lecture by Mr. Charles Aitkin.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

10,963.—Deutsche Hydrier Werke Akt.-Ges.—Carrying out biochemical processes. April 13th.

11,016.—Harris, H.—Separation of alkali stannate, etc., from solutions. April 13th.

10,721.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of basic phenol alkyl ethers. April 11th.

10,836.—Koppers Co. — Apparatus for treating liquids containing tar acid. April 12th.

10,994.—Paterson, W. — Apparatus for testing chlorine content of water, etc. April 13th.

Specifications Published.

288,390.—Takayama, Y.—Method of collecting inorganic potassium salt, betaine salt, and glutamic acid from the waste liquor produced in distilling alcohol from fermented beet molasses.

273,718.—Caro, Dr. N., and Frank, Dr. A. R. — Production of high-per cent. nitric acid.

288,496.—Read, F. F.—Method of and apparatus for identifying crystals.

288,436.—South Metropolitan Gas Co., Parrish, P., Snelling, F. C., and Weight, O. W.—Installations for recovering ammonia from ammoniacal liquor.

Abstract Published.

285,847.—Sulphuric acid. — Soc. Generale Metallurgique de Hoboken, Hoboken-lez-Anvers, Belgium.

A solution of nitrogen oxides in sulphuric acid of 54-62° Be is injected into the atmo-

sphere of the usual lead chambers from nozzles secured to the roof or to the side-walls or below the surface of the acid which collects at the base. The amount of acid which is injected is such that the acid collecting at the base still contains nitrous products, and the acid in the last chambers contains more than that in the first chambers. The acid in the first chamber may become completely denitrated or a separate denitrating tower may be used. A regulating tower of the kind described in Specification 11559/07 consisting of a packed or plate tower rinsed with nitrosylsuphuric acid may be circulated successively through the chambers to theh first chamber from which it is returned to the last chamber, the regulating tower or the Gay-Lussac apparatus. A portion of the acid may be passed in short circuit from the base to the top of each apparatus.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

MUSTERUB.

486,192.—Chemical substances prepared for use in medicine and pharmacy.—Thomas Kerfoot & Co., Limited, Bardsley Vale Mills, Oldham Road, Bardsley, Lancashire. March 28th.

PHYLLOGEN.

486,651.—Chemical substances prepared for use in medicine and pharmacy.—Chlorosan Actien Gesellschaft Chemische Therapeutische Praeparate, im Bruhl 943, Zofingen, Switzerland. April 4th.

POETRY OF SCIENCE.

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CONTENTS. PAGE.

The Atom and Some General Material Properties and Phenomena 289
By Dr. W. Tombrock.

Liver Fluke Disease in Australia 291
By I. Clunies Ross, B.V.Sc.

Great Fillip to Low Temperature Carbonisation 293

Some Attempts to Separate the Isotopes of Magnesium 294
By Tsunekichi Nishimura, Takemaro Yamamoto, and Masae Arai.

Royal Institution.—New Officials 296

Absolute Measurement of Capacitance by Maxwell's Method 297

Proceedings & Noticies of Societies :—
Society of Public Analyists 297
Geological Society 298

Synthetic Nitrate 299

Notices of Books 300

Numerical Relationship of Proportions and Associated Figures 301
By A Sachoschavsky B.S.c .

Forthcoming Events 302

New Patents 303

New Trade Marks 303

FOREIGN COAL, IRON AND STEEL.

European coal outputs were smaller in February than in the corresponding month of 1927 and production in the United States was markedly reduced owing to the labour dispute. There was not a great deal of change in pig iron, but crude steel production was higher on the Continent and in the United States and lower in the United Kingdom.

THE ATOM AND SOME GENERAL MATERIAL PROPERTIES AND PHENOMENA.

By DR. W. TOMBROCK.

We thus thought of the atoms as a proton-mill, in which the number of protons is related to the atomic weight. (See "Atomic Electricity Explained . . . " *Chem. News*, 1928, cxxvi, 193).

What now causes the stability of the atom? One must expect that a number of strongly rotating protons, *taken by themselves*, thus considered in an electron-(ether-) free space, will, on mutual contact, fly apart, and hence form an unstable complex.

The stability must thus be brought about by the combination of the protons with electrons and ether-particles.

Protons do not by themselves attract electrons and ether-particles—we should not be able to understand how—but a proton-mill acts like a whirlpool in the ether-sea or, if one prefers it, like a cyclone in the ether-atmosphere. The rarer the latter is, the more unstable the atom becomes; indeed an atom could not be stable in an ether-vacuum.

The instability of the radioactive substances, in which the atom disintegrates, could thus be caused by an ether-atmosphere which had become rarer. Similarly one may expect, that in the formation of matter perceptible to the senses, the elements with few protons—thus a low atomic weight—would first be formed and from these successively the heavier proton-complexes, especially when, by certain circumstances, the ether-atmosphere becomes denser.

But how do we now, from the atom, arrive at the general properties and phenomena of matter?

Gravitation, as we have already remarked, would have to originate in that the motions of the ether-particles are changed in the proton-mill. In general indeed, an ether-particle which makes a few turns in the proton-mill would obtain less translatory but more rotary motion. The effect would have to be that the ether in the immediate neighbourhood of the atom would become rarer, or, more correctly speaking, the ether pressure would become smaller. Indeed, should the proton-mill completely nullify the translatory motion of the ether-particles passing through, then the proper repulsive force of these particles would thereby disappear, consequently the ether-pressure would diminish; the effect would be as if the ether were rarer.

The latter would make it understandable that this *apparent* rarification of the ether would make itself most felt in *between* various atoms, molecules and observable objects, and the result must be that these *become pressed in towards each other* by the rest of the ether-particles which exert a pressure. It will be as if the proton-mill tried to suck in the ether around it and it is to be considered that the (apparent) force of attraction (gravitation) caused by this must be proportional to the number of protons and *proton-complexes (atoms).*

But then by what are *electrical attraction and repulsion* caused?

Protons and electrons by themselves, as we have supposed, do *not* attract one another mutually; but atoms are yet centres of whirlpools or cyclones in the ether through the strong rotational motion of the protons.

It is thus in these cyclonic motions that we must seek the origin of the electrical forces observed by us.

Let us consider the surface of a material object.

Here by the proton-mills will be produced motions which may be compared with whirlpools on the surface of a sea or river. Some of these whirls rotate with the hands of the clock, *others in the opposite direction.* With electrically neutral amorphous matter there exist no reasons to suppose that one of these types of motion, clockwise or anti-clockwise, should predominate. In general the two forms of ether-sucking whirlpools will be practically equally strongly represented.

But now let extra electrons be brought to this surface by friction or othewise—from outside. Then it is quite possible that these electrons seek by preference one of these two forms of motion, in other words, that they settle especially on whirlpools which rotate clockwise...... or opposite. A displaced equilibrium will hereby produced at our surface, the electrical neutrality is destroyed; one says that the surface is charged negatively by electron excess. And the same *in the opposite sense* may be supposed for a positive charge. In this case also one of the two forms of motion would be able to obtain the upper hand. And it is understandable that a *positively charged* surface would attract a negatively charged one, but that similarly charged surfaces exert a repulsive action on one another.

The same may approximately be considered to hold for *magnetic attraction and repulsion;* however in this case we shall ... a similar *orientation* of cyclonic movements not exclusively on the surface but throughout the whole object.

Light, as we already remarked, is primarily emission, secondarily undulation, a more or less continuous ,incessant stream of rotating electrons, which will have to give a radiation pressure. It also becomes understandable that, through the suctional force of the proton-mills, light is subject to gravitation. The bending of radio waves round the globe may possible be closely connected with this.

We thus see that, roughly speaking, the most obvious properties of matter, gravitation, electricity, magnetism, light, find a *ready explanation in a simple conception* of matter, which in itself contains nothing incomprehensible. But also for some more complicated phenomena does this idea suggest an easy solution.

An electric current in a *conductor* is caused by a transfer of rotating electrons conveyed by a strong ether motion around the conductor.

Valency will originate in the streams of electronic material particles into and out of the *proton-mills......* even the variation of valency becomes understandable from a differing construction or plan of the proton-mill.

Cohesion and *adhesion* require no further explanation.

When, through certain circumstances, much of the surrounding electronic matter is removed from the atom, then there exists a possibility of what we touched upon above, that the proton-complex becomes broken up and separate protons or smaller complexes fly around...... *canal-rays.*

That such free protons or proton-groups, through their greates extent and *strong rotational* motion, can be dangerous projectiles for other atoms has been shown by Rutherford.

And so on.

Can the *period systems* be explained by a building up of the atoms from the same bricks (protons) so that approximately *similar configurations* recur regularly?

Need a more profound explanation of the *spectra* of the various elements deter u here?

May we not think of a kind of surge in the Heaviside-layer between the ether-particles streaming towards the earth and those returning from out its proton-mill?

Is it risky to postulate that in the birth o the atom, the first formation of matter ob

servable by the senses (in the interstellar spaces), there would be produced in the ether oscillations of very short period?...... cosmic (Millikan) *rays*?

April, 1928.

Bergen op Zoom
Holland.

LIVER FLUKE DISEASE IN AUSTRALIA: ITS TREATMENT AND PREVENTION.

By I. Clunies Ross, B.V.Sc.
Veterinary Parasitologist, Council for Scientific & Industrial Research, Australia.

(*Continued from Page* 280.)

Administering capsules. — Capsules are best given by means of a small balling gun, which can readily be made by taking a piece of stiff rubber tubing of approximately 9 inches in length and with an internal diameter of ½ inch. A plunger of cane or wood should be smoothed down so that it runs easily in the barrel, and should be sufficiently long to form a handle. In order to avoid the danger of injury to the sheep's throat, a guard should be placed on the handle so that when the plunger is driven home the end is not less than ⅛ inch from the end of the tubing.

Cost of treatment.—The cost of treatment with carbon tetrachloride varies somewhat according to the method used. If the drug is mixed with liquid paraffin by the stock-owner himself, the cost, allowing for carbon tetrachloride at 3s. per lb. and liquid paraffin at 10s. per gallon, is about ¼d. per sheep. If the mixture is bought ready prepared the cost is approximately ½d. per sheep. If hard gelatine capsules are used and filled by the stockowner, the cost for material is again about ¼d. per sheep, while if soft elastic ready-filled capsules are used, the cost is approximately 1d. per sheep. After a little experience with the balling gun, capsules may be given almost as quickly as the solution, and by either method one operator, with two men catching, can dose up to 2,000 sheep per day. It has been found that there is no marked variation in the efficacy of the drug whether it be given in capsules or in solution. Usually, stock-owners will be found to keep to the first method of administration of which they have had satisfactory experience. Both methods have their advantages and disadvantages. By giving capsules, there is always the possibility that an occasional sheep may not swallow the capsule and so escape treatment, while in using the hard gelatine capsules, though the gelatine will not be dissolved by its contents for many weeks, there is often leakage from under the cap. In giving the drug in solution, and especially where sheep are roughly and carelessly handled, there is some risk of the head being forced too far back, and some of the solution getting into the windpipe; also unless the mixture is carefully bottled and protected from evaporation, a considerable proportion of the carbon tetrachloride may be lost.

Precautions to be observed in dosing with carbon tetrachloride. — Sheep should be dosed standing. The head should be slightly raised but not forced backwards, otherwise difficulty in swallowing will cause danger from inhalation. In giving the drug in solution, the bottom jaw should never be tightly held so that the sheep is prevented from swallowing easily when the dose is delivered. Do not give more than the dose of 1 c.c. (16 drops) since larger doses will not increase the efficacy of the drug and may cause ill effects. It is not necessary to withhold food or water before or after dosing, but sheep are usually yarded overnight and treated in the morning. It is advisable, however, where sheep have been hand-fed on concentrates such as linseed nuts, to withhold these for one week before dosing.

When to treat with carbon tetrachloride. —Owing to the seasonal escape of young fluke from the snail, sheep pick up their heaviest infestation in the late summer and autumn months, though they may continue to pick up some fluke throughout the winter. It has been found that carbon tetrachloride will not kill the fluke until they have reached the bile ducts, and this does not occur until several weeks after they have entered the sheep. The first treatment should therefore be given in the early winter, as soon as possible after the majority of the fluke picked up in the summer and autumn (January to April) have reached the bile ducts, that is, about the middle of May. Owing to the fact that some of the small fluke already in the sheep may not be killed by a single treatment, it is advisable, in districts where infestation is usually heavy, to give a second treatment about the beginning of July. Where it is not practicable to give two treatments the first should be given a little later, about the first week in June. The necessity for giving two treatments will be largely determined by the effects of the first. Should the sheep a month or six weeks later show little sign of improvement in condition and still exhibit symptoms of fluke disease, a second treatment is advisable.

Sheep in advanced stages of liver rot may be treated without danger other than that due to handling, and will usually commence to show a marked improvement in condition within a few days. Ewes in lamb should not be treated within three weeks prior to lambing owing to the danger from handling; otherwise dosing with carbon tetracholride either before or after lambing does not appear to be harmful to the lambs.

Reports of mortality in sheep after dosing with carbon tetrachloride are made from time to time, but it is seldom that such mortality can be directly attributed to its use. In many cases the mortality has commenced before dosing, in others it has been due to other causes, while in some instances the purity of the drug used has been questionable. In any case where sheep are badly affected with fluke, the benefits accruing from the treatment are such as greatly to outweigh all reasonable objections, and to justify taking the risk of any slight mortality which might occur.

The Prevention of Fluke Disease.

Though medicinal treatment for fluke is very useful in improving the condition of the flock and saving many sheep which would otherwise die of fluke disease, it must be remembered that alone it will never affect the total eradication of fluke, and it is therefore *not the most desirable method* of controlling the disease. Moreover, in will not save a large number of sheep which die of acute fluke disease at the time the young fluke enter the liver, nor will it prevent re-infestation. It is therefore all-important that other measures should be adopted by which the disease may be eradicated for all time, rather than merely to lessen losses from year to year.

In considering the life-cycle of the parasite it was seen that two things were necessary for its survival—(i) marshy or boggy areas over which sheep can graze and in which the fluke eggs will hatch, and (ii) certain fresh-water snails in which the fluke must develop. It was further shown that these dangerous conditions existed particularly in the vicinity of springs and bogs, or along the course of slow-running marshy streams. Preventive measures must therefore aim at treating these dangerous sites so that the area of marsh and bog is reduced to a *minimum, and at the destruction of all* fresh-water snails present in these places. The first of these aims can be achieved very largely by proper drainage, while the second [illegible] possible by the use of

Drainage of marsh land.—Where practicable, all marshy areas should be efficiently drained. In the case of springs, a channel should e dug to carry water away so that it no longer spreads out to form a bog but is drained straight down to the nearest natural channel, which should also be cleared of weeds and deepened. In the case of clear springs which are of value for watering purposes, these may be rendered safe by bricking or concreting the sides and then piping the water off to troughs from which stock are watered. Where this is done, precautions must be taken to see that the overflow from the trough does not again lead to new bog formation which would soon become a breeding centre for snails. It is not uncommon to find both troughs and the bog surrounding them to contain numerous snails. Owing to the danger that exists of any young fluke which are floating on the surface of water being carried a considerable distance, it is necessary before piping water from springs first to treat the spring so that all snails in it are killed.

Slow-running streams with swampy backwaters should have their central channel deepened, the sides cut clear and *freed from all grass and weeds.* Other extensive areas of boggy land should be drained by digging lateral drains opening herringbone fashion into a central channel which leads down to some safe watercourse.

The use of bluestone.—The most suitable chemical to use for the destruction of snails is copper sulphate or "bluestone," which, when present in very minute quantities in water, is rapidly fatal to all snails. The aim in the use of "bluestone" is to form a weak solution of this chemical in all the water of the areas in which fluke snails exist. In the case of pools and springs this may be done by first breaking the copper sulphate in small pieces, tieing them in a bag attached to the end of a pole, and then dragging this bag backwards and forwards through the water till the latter acquires a faint blue tinge. In the case of running streams, bags of bluestone may be placed at intervals along the course of the stream so that the chemical is gradually dissolved. While these methods are effective in certain cases, they are quite ineffective in others, as for example, slowrunning streams with stagnant backwaters and in irregular marshy areas. It can be seen that in a shallow, slow-running stream though the bluestone is carried down along the main channel and may kill all the snails there, it often entirely fails to reach the weedy backwaters

are just the places which are most dangerous to sheep, and in a stream so treated they will often be found to contain numerous snails though the stock-owner is confident that he has rendered the area quite safe. Such streams, and all shallow boggy areas, can best be satisfactorily treated by broadcasting bluestone, after grinding the latter to a fine powder and mixing it with sand.

Broadcasting bluestone. — A satisfactory mixture is made by mixing 1 part of bluestone with 4 of sand and then broadcasting by hand at the rate of 30 lb. of bluestone per acre. Thus 30 lb. of bluestone are mixed with 120 lb. of sand, making 150 lb. of the mixture to be applied per acre. Just before use, the bluestone should be freshly ground to a fine uniform powder and then thoroughly mixed with the requisite quantity of sand. Before grinding, it is important to see that the bluestons is in the form of hard blue crystals, and that it is not white and powdery. In estimating the quantity to be used the approximate length and breadth of the area to be treated is taken and number of acres so found. Just a sufficient quantity of bluestone to treat the area in question should be used.

The cost of this method of treatment is not great. Bluestone may be purchased at approximately 4d. per lb. in cwt lots (less for larger quantities), and about 2 acres per day can be thoroughly treated by one man. One of the chief labour items is that entailed in powdering the buestone before use. This is best done by first breaking up the big pieces with a large hammer until they are of a size to be taken by a small domestic hand crusher. These crushers can be purchased for about 30s., and at least 10 lb. of bluestone can be powdered by them in an hour.

Cost of broadcasting.—The apprpoximate cost of broadcasting bluestone should not be more than 25s. per acre, made up as follows :—

30 lb. of bluestone at 4d. per lb	£0	10	0
Powdering of bluestone, 30 lb. half-day's labour at 15s. day	0	7	6
Applying bluestone at the rate of 2 acres per day, i.e., half-day's labour	0	7	6
Cost per acre	£1	5	0

In treating streams by this method, care must be taken that the bluestone is spread not only over places actually covered by water, but also those places which though not under water are still moist. It is known that the fluke snails though killed by complete dryness are able to exist for considerable periods in apparently dry places. As the water recedes, the snails make their way into the cracks in the mud, and situations which are apparently dry and free from snails may actually harbour considerable numbers of them in the moist mud below the surface. With the first shower of rain, snails so hidden will emerge. It is therefore necessary when treating a slow-running stream, or marsh, to spread the copper sulphate over a margin beyond the limits of the obviously wet areas.

Though the use of bluestone will rapidly prove fatal to snails, it does not affect vegetation nor has it been found to cause any ill effects to stock. In order, however, *to avoid all risks of poisoning through stock, grazing over freshly treated areas* animals should be kept off these for one week, or preferably until a shower of rain has fallen. It should be remembered also that the use of bluestone in the manner prescribed will kill fish.

GREAT FILLIP TO LOW TEMPERATURE CARBONISATION.

Fuel Supplies for the Army and Air Force.

"The preference given to British-produced oil from coal provides practical—almost dramatic — recognition by the Government that the day of the successful commercial exploitation of low temperature carbonisation has arrived," said Lt.-Col. W. A. Bristow, the well-known engineer and Managing Director of Low Temperature Carbonisation Ltd., in an interview.

"It is calculated to tip the balance in the case of scores of colliery companies and the great industrial concerns which have been waiting for assurances of commercial success before they embark on the installation of coal distillation plants. It is quite possible, however, that one result of the preference will be a recrudescence of the outbreak of unpractical wild-cat schemes for extracting fabulous quantities of oil and spirit from coal; and in my opinion, if low temperature carbonisation is to develop along sound lines, it must aim at :—

1. The production of a perfect smokeless domestic fuel to replace raw coal supplies at an economic price.
2. The production of industrial smokeless fuel, for pulverisation and other purposes, from the inferior small coal and slack.
3. The extraction under proved processes

of the maximum quantity of by products, crude oil, crude spirit and rich gas.

"At the present time we are producing every week at our works at Barugh, Yorkshire, out of 1,500 tons of best washed smalls, 27,000 gallons of oil, and 3,500 gallons of motor spirit," continued Col. Bristow, "and when it is recollected that in the Coal Commission's report it was estimated that British Mines produce annually 60 million tons of slack, much of which is quite suitable for the production of industrial smokeless fuel and motor oils, it will be seen that the Budget of 1928 will mark the dawn of a completely new career for the mining and oil industries of this country.

"I am now in a position to announce that my Company has recently made arrangements for the erection of a few of the contemplated new plants in this country, and those actually at the pit head will naturally be in a favourable position and the first to operate. We shall immediately establish a large organisation to deal with a great increase in the volume of business."

Col. Bristow pointed out that the potential demand for coal, oil and spirit, was unquestionable, because of its inherent good properties. For example, its "anti-knock" characteristics would eliminate the necessity for the use of metallic salts.

"From the national standpoint the Budget scheme is fraught with the utmost possibilities," continued Col. Bristow. The Air Force, our first line of defence, has up to the present been wholly dependent on the use of imported fuel, but this situation will now be entirely charged. It is possible to refine coal oil in such a manner as to make the resultant spirit suitable for every class of aviation motor, irrespective of compression ratio and working temperature. Supplies of liquid fuel for the Navy will likewise be augmented from a source which will make us independent of foreign supplies, and thereby enable us to avert the recurrence of our anxious experiences of the War.

"It will have an important effect on the present state of the coal industry, one of the greatest problems of which has been the very high percentage of small coal, which has retarded the profitable working of even the best collieries. Low temperature carbonisation has already done much to brighten the prospect of colliery companies, but the Budget preference will be of paramount importance, and I foresee that in the near future there will be a wholesale adop-

SOME ATTEMPTS TO SEPARATE THE ISOTOPES OF MAGNESIUM.

By Tsunekichi Nishimura, Takemaro Yamamoto, and Masae Arai.

(*Abstracted from the Bulletin of the Institute of Physical and Chemical Research, Tokyo*, 1928, VII, 237-256).

In attempting to separate the isotopes of magnesium, the authors have chosen the two following cases as having the greatest probability of revealing the differences between the said isotopes :—

(1) Difference manifested on remnant combining forces.

(2) Difference in degree of adaptability in case of forming a certain common structure between salts of other kinds.

(1) Inasmuch as it concerns with combining forces remaining after the principal combining force has been satiated, the difference in reacting capacity then revealed will be akin to the second difference in its nature, and so it may be deemed to present a far greater disparity than the case of direct combination in the comparative ratio, however small may that difference be in its absolute value.

Under (2) there is implied the idea presuming an atomic deformation of a certain sense which will be generated responding to some external force such for example as a specially directed strong force similar to a statical electric force due to the charge in other ions close by. When a metallic ion enters into a common structure with some metallic ions of different kind, such for example as it forms a double salt or a solid solution, the two members must satisfy a common condition in a certain sense. Of what the substance of that concrete condition shall consist may be imagined in several ways; but leaving this aside for a while, it may still be supposed without much difficulty that there will take place inside the atoms themselves, some change in a certain sense of adaptation to each other. This "accommodating property" so to speak, is meant to be caused by some change inside the atom of the sense of a certain sort of deformation which makes up the source of responding force thought to come into existence responding and proportional to some external forces. Whatever be the true cause, the accommodating property in the above sense, as a matter of fact, is in general more significantly manifested as the atomic weight increases for those elements of the same family in the periodic system. For

certain type between an alkaline metal, it is ascertained as a fact that the resulting double salt increases in stability as the two metals becom higher in their atomic weights, at the same time the range of stable subsistence being extended. Since the greatness of atomic weight implies complexity of internal structure, if the so-called accommodating property of atoms be caused by a change in the sense of a certain sort of deformation, it is very naturally conceivable that as the atomic structure becomes complex so the deformative capacity responding to external forces will be enhanced.

Magnesium should be expected to present the accommodating property in a comparatively low degree as looked from its position in the periodic law. Hence, in the case of its forming a double salt with some other powerful cation such as potassium-ion, it is considered to approach the limit of internal deformation comparatively soon. Hence, presuming that there are some differences in deforming properties among isotopes, a comparatively large difference should be revealed for such a case.

Chemical forms used in the experiments for separating the isotopes of magnesium were :

(a) Basic magnesium chloride $Mg\ Cl_2 3Mg (OH)_2.NH_2O$,
(b) Magnesium bicarbonate (as solution).
(c) Carnallite $Mg\ Cl_2.K\ Cl.6H_2O$.

Among those, (a) and (b) were used on the idea in the case (1), while (c) was taken for (2). Notwithstanding, the authors are by no means considering either basic magnesium chloride or magnesium bicarbonate as being a so-called molecular compound. On the contrary, they are rather sceptical about the existence of a molecular compound of this sort, and meant to utilise their experiments for some aid in ascertaining such ideas. Again, what was chiefly aimed at those experiments was whether it would not be possible, according to such ideas, to reveal to a certain degree, the atomic deformation upon concrete facts.

The results attained may be outlined as follows :—

(a) One part of magnesium chloride in the form of basic salt was separated out by adding magnesium oxide to a concentrated solution of magnesium chloride at ordinary temperature, and then this basic salt was turned back to magnesium chloride by hydrolysis. The same treatment was repeated twice more. On the other side, from a concentrated solution of magnesium chloride, a small quantity of the same was excluded as times. Among the two portions of magnesium chloride in solution thus obtained by the two different methods, there may be expected to lie respectively one kind of magnesium taking the form of basic magnesium chloride $MgCl_2.3Mg(OH)_2.nH_2O$ in solid phase rather easily, and the other so doing not so earily. By measuring, however, the atomic weights of those two, any difference failed to be detected.

(b) In separating out magnesium carbonate in the form $MgCO_3.3H_2O$, air was passed in ordinary temperature through an acidic magnesium carbonate solution saturated under ordinary pressure by magnesium carbonate. A small portion which then separates out first and another portion which remains in solution to the last are collected separately, and the treatment was repeated twice more on each portion. In other words by repeating three times each of dissolving and separating out, that portion easy of separation and the other most liable to remain in solution were collected repeatedly. On measuring the atomic weight of magnesium in those two portions, that which is most liable to remain in solution gave an atomic weight greater by 0.11 in average than the other.

(c)By adding potassium chloride into a concentrated solution of magnesium chloride in ordinary temperature, a part of magnesium chloride was separated out in crystals of carnallite $MgCl_2.KCl.6\ H_2O$, and this carnallite is turned back to a solution of magnesium chloride by hydrolysis. The same process was repeated seven times. On the other side, a part of magnesium chloride was excluded as carnallite by adding potassium chloride to a concentrated solution of magnesium chloride. The process of this exclusion for the same solution was repeated seven times one after another. In the solutions of magnesium chloride obtained by the two processes, there should be expected two sorts of the salt in comparatively large quantities, one taking the form o fcarnallite rather easily, and the other doing not so easily. As the result of measuring the atomic weight of magnesium in those two portions, that which remains in the original solution, i.e., takes tbe form of carnallite with difficulty gave an atomic weight greater by 0.15 in average larger than the other.

In the determination of the atomic weight stated above, magnesium carbonate was prepared at first, and magnesium oxide therein was volumetrically measured by means of the normal solution of sulphuric acid. Afterwards, this was gravimetrically

nesium sulphate. In each individual number for the atomic weight there may lie an error less than 0.12, so that the numerical values cited above cannot yet be taken as definite, and should be verified sometimes by other more accurate determination.

GENERAL NOTES.

ROYAL INSTITUTION.—NEW OFFICIALS.

The annual meeting of the members of the Royal Institution was held at their house in Albemarle Street on May 1. The report of the Board of Visitors, which was adopted, showed that the membership numbered 917 at the end of December last, against 890 on the same date in the previous year.

The ballot for new officers was taken and resulted as follows :—

President—The Duke of Northumberland.

Treasurer—Sir Arthur Keith.

Secretary—Sir Robert Robertson.

Managers—Lord Blanesburgh, Sir James Crichton-Browne, Dr. J. Mitchell Bruce, Mr. Alfred Carpmael, Professor F. G. Donnan, Sir James Dundas-Grant, Lord Falmouth, Sir Robert Hadfield, Mr. J. S. Highfield, Mr. W. E. Lawson Johnston, Coloned Sir Henry Lyons, Mr. C. H. Merz, Mr. Saxton W. Noble, Sir Richard Paget, and Dr. G. C. Simpson.

Visitors—Professor N da C. Andrade, Mr. Alexander Glegg, Commander A. C. Goolden, Mr. W. Vaux Graham, Mr. K. R. Hay, Sir Lawrence Jones, Dr. V. W. Low, Mr. William Macnab, Mr. Emile S. Mond, Dr. W. A. Milligan, Mr. C. C. Paterson, Dr. E. H. Rayner, Mr. H. M. Ross, Mr. Sidney Skinner, and Mr. W. J. Tennant.

ANTIMONY IN CANADA.

By Arthur Buisson,
Mines Branch, Department of Mines,
Ottawa.

Although the production of antimony from Canadian mines was first recorded in 1886, shipments have been somewhat erratic and production has gradually fallen off largely on account of the decline in the market price of this metal. Ores of antimony are known to occur, however, in British Columbia, New Brunswick, Nova Scotia, Ontario, Quebec and Yukon and there are indications of a renewal of interest which may result in antimony being

The Lake George antimony mine, situated in York county, New Brunswick, is the most important deposit in that province, and is now controlled by the Canadian International Corporation of Montreal. It is the intention of the Canadian International to incorporate an operating company to be known as the "Antimony Smelting and Refining Company." No crude ore will be shipped and the company will devote its energies to the production of antimony regulus. The Lake George ore is stibnite but native antimony is also found. Production from 1907 to 1922, according to the record of the Dominion Department of Mines, reached a little over 2,200 tons of ore.

In Nova Scotia antimonial-gold deposits have been operated at West Gore, Hants county, first in 1884 in what was then known as the Rawdon mine, later called the West Gore property. Operations were carried on intermittently for several years.

A concentrator was completed in 1908, but operated only for a short time. The property was last operated in 1915 and 1916. The ore shipped ran 15 to 20 per cent. of metallic antimony and contained from 2 to 3 ounces of gold per ton. The concentrates produced contained on the average about 40 per cent. of metallic antimony. About 4,000 tons of ore and 2,200 tons of concentrates have been shipped to date. Some surface prospecting was carried on in the neighbourhood of the West Gore during 1927.

In Yukon Territory antimonial-silver ores occur on Carbon Hill, near the Wheaton River, Wheaton district. While small quantities of sorted ore have been shipped, concentration would be necessary if any considerable production was attempted. On the Fleming property values as high as 50 per cent. metallic antimony have been obtained, with silver averaging from 15 to 20 ounces per ton.

The Consolidated Mining and Smelting Company has made provision for the recovery of antimony as a by-product from the silver refinery of their plant at Trail, B.C. This operation is still in the experimental stage, but a small production of refined antimony may be expected in the near future. Antimony is also recovered in small quantities from the silver-lead-bismuth bullion obtained by smelters treating silver-cobalt ores. During 1926 there were 1,596 pounds of antimony valued at $281 con-

NEW RESEARCH FELLOWSHIPS IN METALURGY AND MINING, 1928-1929.

In co-operation with the United States Bureau of Mines and the State Mining Experiment Station, the School of Mines and Metallurgy of the University of Missouri offers four fellowships. These fellowships are open to graduates who have the equivalent of a Bachelor of Science degree and have had the proper training in mining, metallurgy, or chemistry, and who are qualified to undertake research work. The income of each fellowship is $800 for ten months beginning September 1, 1928. Fellows pay fees amounting to approximately $42 per year.

Fellows will register as students in the School of Mines and Metallurgy of the University of Science (unless this or an equivalent degree has been earned). Their class work will be directed by the heads of the departments of instruction, but the greater portion of their time will be spent in reasearch work under the direction of the Bureau of Mines staff resident at the School of Mines. The purpose of this work is to undertake the solution of definite problems confronting the mining and metallurgical industries of the State of Missouri. For 1928-29 the four fellowships will be granted in the following subjects :

" Ore Dressing : Problems in Gravity Concentration and Flotation."

Applications, with a certified copy of collegiate record, statement of professional experience, and names and addresses of three references will be received up to June 15, 1928.

Applications should be addressed Director, School of Mines and Metallurgy, University of Missouri, Rolla, Missouri.

ABSOLUTE MEASUREMENT OF CAPACITANCE BY MAXWELL'S METHOD.

By Harvey L. Curtis and Charles Moon.
(*U.S.A. Bureau of Standards.*)

Abstract.

The absolute measurement of capacitance by Maxwell's method is based on the assumption that certain conditions are fulfilled by the experimental apparatus. While there are at least seven of these conditions, the most important is that the galvanometer correctly integrates the current. When large capacitances are measured, a galvanometer is required in which the current through the coil does not affect the magnet spect to the magnet this condition can be fulfilled in most galvanometers. However, this adjustment is greatly simplified by a proper design of the galvanometer.

The method requires that a condenser shall be charged and discharged at a known rate. To accomplish this, contacts of platinum dipping in mercury cups have been placed on the prongs of a tuuing fork driven by an electron tubs. This permits the Maxwel bridge to be balanced with the same ease and accuracy as a Wheatstone bridge. However, it is necessary to determine the frequency of the gork at the time of measurement. For this purpose the fork is compared with a freely vibrating pendulum by a method which gives an accuracy of a part in a million with observations which extend over a few minutes' time.

The possibility of introducing systematic errors has been guarded against by employing two inrependent bridges in which the factors have been varied as much as possible. Results are given showing the accuracy that can be attained.

THE INSTITUTION OF GAS ENGINEERS.

At a Special Meeting held recently were unanimously passed the Terms of the Petition, Charter and By-Laws for submitting to H.M. Privy Council.

It is hoped that the firs tAnnual Meeting under the Royal Charter will be held at Cardiff under the Presidency of Mr. H. Dacre Madden, M.Inst.C.E., M.I.Mech.E., opening on June 12, on which day H.R.H. The Prince of Wales, First Hon. Life Member of the Chartered Institution, will be visiting Cardiff to unveil the Welsh National War Memorial.

The Lord Mayor of Cardiff and the President of the Institution will meet the Prince at the Railway Station on his arrival.

Proceedings and Notices of Societies.

SOCIETY OF PUBLIC ANALYSTS.

An Ordinary Meeting of the Society was held in the Chemical Society's Rooms, Burlington House, on Wednesday, April 4, the President, Mr. Edward Hinks, being in the chair.

Certificates were read for the first time in favour of Arthur Duncan Gay, John Gordon Mayne, Reginald Arthur McNicol, M.Sc.

A.R.C.S., D.I.C., A.I.C., Charles Frederick Turner, F.I.C.

Certificates were read for the second time in favour of Frank Rowland Hill, B.Sc., A.I.C., Edward Thomas Illling, B.Sc., F.I.C., Farid Iskander, Harry Bulmer Marston, B.Sc., A.I.C., Reginald James Munro, B.Sc., A.I.C., John Ralph Nicholls, B.Sc., F.I.C., H. Gordon Reeves, D.Sc., Ph.D., F.I.C., George Walsh, B.Sc., A.I.C., Ronald George Warren, B.Sc., William Arthur Waygood, B.Sc., A.R.C.S., A.I.C.

The following were elected Members of the Society :—John Edmund Aps, Edward Eric Billington, M.Sc., Ralph C. Chirnside, Ralph David Owen, A.I.C., A.M.I.Chem.E.

The following papers were read and discussed :—

Coffee Parchment as an Adulterant of Bran and Sharps. By JOHN EVANS, F.I.C., AND T. E. WALLIS, B.Sc., F.I.C.

The practice of adulterating bran and sharps with coffee parchment husk has recently been revived. The "parchment" consists of the thin and tough endocarp of the coffee fruit, and may be recognised by its distinctive cellular structure. When added to sharps it is usually finely comminuted, and in testing a sample a few of the suspicious pieces should be boiled with chloral hydrate solution until transparent, and a fragment mounted in chloral hydrate for microscopical examination.

Determination of the Colour-producing Constituents of the Cacao Bean. By W. B. ADAM, M.A., A.I.C.

The two principal colour-producing constituents in the cacao bean are cacao catechin and cacao tannin. The former has been extracted with ether (after previous removal of fat and xanthine base) and determined colorimetrically by means of Mitchell's ferrous tartrate reagent, whilst the cacoa tannin is extracted with hot water and determined by precipitation as cinchonine tannate. Analytical figures were given showing the percentages of catechin and tannin in the principal classes of cacao beans. The work has shown that the catechin is destroyed during fermentation, and the tannin is reduced to about 2 per cent.

Determination of Vanadium in Steel. By A. T. ETHERIDGE, Ph.D., F.I.C.

The method consists in removing iron (as chloride by extraction with ether) and other interfering metals, by electrolysis over a mercury cathode, leaving a solution in which the vanadium can be determined by of steels: In the case of molybdenum steels the molybdenum is removed together with the ferric chloride on extraction with ether. Manganese, like aluminium, has no influence on the final permanganate titration.

Colormetric Determination of Small Quantities of Antimony and their Separation from Tin. By S. G. CLARKE, B.Sc., A.I.C.

The antimony is deposited on metallic copper as in the Reinsch method, the deposited film stripped off by means of sodium peroxide, and the antimony determined colorimetrically by converting the golden-yellow compound formed by its interaction with pyridine and an iodide, and matching the colour with that produced by a standard solution of antimony. The method is applicable to antimony in either state of oxidation, and in the presence of tin or arsenic, but bismuth and several of the other heavy metals give precipitates, usually coloured, with the reagents.

Determination of Carbon Dioxide in Soils. By A. RIAD, B.Sc., Ph.D.

Hepburn's modification of the Van Slyke method of determining carbon dioxide in carbonates (in which the evolved gas is absorbed in standard baryta solution, the excess of which is titrated with oxalic acid), has been adapted to the determination of carbon dioxide in soils. The results quoted show that the method may be recommended as a suitable one for general soil analysis.

GEOLOGICAL SOCIETY OF LONDON.

The following papers were read at the meeting held on April 18th, Prof. J. W. Gregory, D.Sc., F.R.S., President, in the Chair.

The Succession and Structure of the Borrowdale Volcanic Series in Troutbeck, Kentmere, and the Western Part of Long Sleddale (Westmorland). By GEORGE HOOLE MITCHELL, Ph.D., M.Sc., F.G.S.

The area described lies in the eastern part of the Lake District south of the High Street range. It is drained by the Rivers Sprint Kent ,and Trout Beck, all of which flow in a southward direction.

The rocks described belong to the Borrowdale Volcanic Series. The estimated thickness of such members of the series as are exposed is approximately 3700 feet, but nowhere is the base seen. They are overlaid unconformably by the Coniston Limestone Series. Nine subdivisions are recog

Andesites; (g) Coarse tuffs; (f) Wrengill Andesites; (e) Kentmere Pike Rhyolites; (d) Bedded tuffs, with andesite-flows; (c) Harter Fell Andesites; (b) Froswick Tuffs, with rhyolite-flow; (a) Nan Bield Andesites.

There are also minor intrusions of rhyolite, quartz-porphyry, andesite, and lamprophyre.

The lava-flows range in composition from rhyolites to augite-andesites. In most cases flow-brecciation is evident and marked, while many of the andesites are intensely vesicular.

The tuffs, composed in the main of andesitic material, show in many deposits rhyolitic fragments in abundance, and range from very fine-grained and well-bedded examples to ill-assorted agglomerates.

The rocks have been subjected to severe earth-movements. Two systems of folding are recognised, an earlier one of pre-Bala age and a later one of Devonian age. The former system, of simple character, shows axes trending in a north north-easterly and south-south-westerly direction. In the latter the folding was intense, with an east-north-easterly and west-south-westerly strike, while the pitch of the folds was determined by the folds of pre-Bala date. The rocks are steeply folded in the south-east of the area, and the folds are even overturned to the north. Northwards the folding is less severe, and is marked by the presence of a broad anticlinal fold.

No faulting of earlier date has been recognised, but several faults are referred to the Devonian system of earth-movements, while it is suggested that several north-and-south faults are of late-Carboniferous age.

The rocks are strongly cleaved, the strike of the cleavage coinciding with that of the Devonian folding.

The Geology of the Marquesas Islands (Central Pacific). By LAWRENCE JOHN CHUBB, B.Sc. (Communicated by the Secretary.)

The Marquesas Islands are situated in about 10° lat. S. and 140° long. W. With one doubtful exception all are of volcanic origin. The southernmost, Fatu Hiva, consists of a caldera composed chiefly of lava-flows, within which an ash-cone has been built up. The western half of the whole structure has disappeared, apparently owing to submergence by faulting. Montane is a small ash island. Tahuata is larger, and it is also composed chiefly of ashes in its northern part; its south-eastern side has been faulted down. In Hiva Oa there are three great craters in the western part, some elevated plateau at a height of 1300 to 1500 feet above sea level. Nuka Hiva has a structure similar to that of Fatu Hiva, and it bears a plateau at an elevation of 2600 feet.

A consideration of the directions of elongation of the islands, of the manner in which they are arranged, of the trends of the faulted coasts, and of the strikes of the dykes, leads to the conclusion that the group is situated, not on a crustal fold, but on a system of intersecting fissures.

The uplifted plateaux prove that elevation has occurred, but the embayment of the mouths of the streams that deeply dissect them affords evidence of a later subsidence. All the islands are surrounded by a shore-shelf, now standing, owing to a recent fall in sea-level, 3 or 4 feet above high-water mark.

It is suggested that the poor development of coral-reefs in the group is due chiefly to periodic chilling of the water by extensions of the cold Peruvian Current, connected with cyclic climatic changes.

SYNTHETIC NITRATE.

INTERNATIONAL FINANCE FOR BIG GERMAN PROJECT.

Offering was being made in New York on May 3, by Messrs. Dillon Read & Co., of \$4,000,000 (£819,000) twenty-year 6 per cent. mortgage bonds of the Ruhr Chemicals Corporation (Ruhrchemie A.G.), a company recently formed by 28 of the leading Ruhr colliery and steel interests to utilise the waste coke-oven gases of the Ruhr for the manufacture of synthetic nitrate fertilisers. The bonds, which are a direct mortgage lien on the company's property and are further secured by the assignment to trustees of two-thirds of the share capital (R.M. 27,000,000), are being offered at 92¼ to yield 6.71 per cent. to maturity. Part of the issue is to be placed in Amsterdam, Germany, and Switzerland. Annual sinking fund payments of \$211,000 (£42,000) will provide for the redemption of the bonds at par and interests. Proceeds of the issue will be used for financing part of the cost of the Company's first producing unit.

The new company, whose stockholders, headed by the United Steel Works Corporation (Vereinigte Stahlwerke A.G.), include the Thyssen, Stinnes, Krupp and other important Ruhr concerns, controlling between them 70 per cent. of the coke-oven gas production of the Ruhr, will use the Concordia

producing annually 300,000 tons of synthetic nitrate is already under construction and the first unit at Holten, near the Rhine, will be ready early next year with an initial output of 16,100 tons.

Net profits for a normal year's working are estimated by the directors at $1,200,000 (£245,000). Owing to the low cost of production under the new processes, it is expected that the marketing of the Company's fertilisers will have important repercussions on the nitrate industry generally. The present surplus of coke-oven gas in the Ruhr area is estimated at approximately 9,000 million cubic metres annually, and this is sufficient to cover the requirements of the Ruhr Chemicals Corporation more than ten times.

NOTICES OF BOOKS.

The Chemistry of Leather Manufacture. By JOHN A. WILSON, Chief Chemist, A. F. Gallan & Sons & Co., Tanners, Milwaukee, Wisconsin. Pp. 496. Price $10. New York: The Chemical Catalog Company, Inc., 419, Fourth Avenue, at 29th Street, New York, U.S.A.

This is Monograph No. 12, issued by the American Chemical Society, and the series is so deservedly popular that no encomiums are necessary to recommend them to the public. When leather is considered, its antiquity, its essentiality, and its universal use, it will at once be understood that a scientific work on its chemistry and manufacture must prove interesting to a vast number of people. The present is a second edition in English of the work, the first edition in 1925 being followed by an edition each in French, German and Russian, an evidence of its widespread popularity. Authenticity was secured by the fact that as each chapter was written it was sent to competent chemists or experts on the points dealt with, and then rigidly revised to meet the observations and criticisms given. There are numerous illustrations.

Reports of the Progress of Applied Chemistry. Issued by the Society of Chemical Industry. 1927. Pp. 742. Price, 7s. 6d. London: Society of Chemical Industry, Central House, 46, 47, Finsbury Square, E.C.2.

This is both a useful and interesting book, its contents are varied and authentic—the combined labours of over thirty competent chemists. Among the contents are chapters mineral oils, colouring matters and dyes, fibres, etc., bleaching, dyeing and printing; acids, alkalis and salts; glass, refractories, ceramics, cements, iron and steel, electrochemical industries, oils, fats and waxes; paints, pigments and varnishes; india-rubber, leather and glue; soils and fertilisers; sugars; foods; sanitation; fine chemicals, etc., etc. The book is a marvel of cheapness.

The Evolution of Scientific Thought from Newton to Einstein. By A. d'ABRO. Pp. xx + 544. New York: Boni and Liveright. 1927.

This extensive volume—each page contains about 600 words—deals in a masterly manner with the development of modern mathematical and scientific thought. The work is divided into four parts; the first is concerned with pre-relativity physics, the second with the special, and the third with the general theory of relativity. Part 4 indicates the methodology of science. There are four appendices on Space, Time and Gravitation.

A feature of the book is that it sets out the new discoveries in relation to the whole scheme of scientific thought. The idea that non-Euclidean geometry, relativity and other recent advances have upset the structure of science is misleading. The author shows that these are growths and manifestations of the continuous life of human knowledge.

Although during the last few centuries, scientific theories have come and gone, the governing principles have remained the same. There has been an extended search fo runity in diversitp and a desire to bring order and harmony into the chaos of facts.

Mr. d'Abro's aim has been to direct attention to scientific methodology. The essentials of Newton's great discoveries and the apparent inevitableness of absolute time and space are passed in review. He passes on to Riemann's work to which he attaches much importance for it anticipated the conclusions of Einstein.

J. G. F. D.

RECENT GERMAN LITERATURE.

Fluorescenz und Phosphorescenz. By P. PRINGSHEIM. Third Edition. Pp. VIII + 360. Berlin: Julius Springer. 1928. Price 24m.

This important monograph is one of a series issued under the editorship of Profs. Born and Franck. The subject is con-

concerning the nature of atomic structure which is shown to be intimately related to the phenomena of phosphorescence and fluorescence. These have recently attracted attention and a new edition of the work under notice has been called for. All aspects of these phenomena are considered and there are over 600 references to recent contributions on the subject.

Veroffentlichunger aus dem K. W Institut fur Silikatforschung. By Dr. W. Eitel. Pp. 269. Berlin: Gebrüder Borntraeger. 1928. Price 28m.

This compilation by Dr. Eitel, dedicated to Prof. A. von Harnack, is a collection of 20 papers (one in English) emanating from the Kaiser Wilhelm Institut für Silikatforschung. They deal principally with the application of optical and physical methods in the study of the structure of minerals, especiallp silicates and clays.

Atomstruktur und Atombindung. By Prof. J. Stark. Pp. xviii + 198. Berlin: A. Seydel. 1928. Price 9m.

This book is concerned with the space configuration of the chemical atom and molecule. The first section details the fundamental nature of atomic structure, whilst the second is concerned with the exact structure of the atoms of typical elements and the third section is devoted to a discussion of atomic combinations.

Lehrbuch der Physikalischen Chemie. By Prof. K. Jellinek. Second edition. Vol. V, Book I. Pp. 272. Stuttgart: Ferdinand Enke. 1928. Price 21m.

This is another section of Prof. Jellinek's Lehrbuch and deals extaustively with the states of aggregation, with special reference to solids. The subject is treated from the experimental, thermodynamic and kinetic standpoints.

Messrs. Gautier-Villars have just issued a 64-page catalogue of their recent publications of medical and scientific works arranged alphabetically. A summary of the contents and sometimes a review accompanies each title.

IMPORTANT WORKS ON CHEMISTRY.

Longmans, Green & Co.'s Publications.

On our front page will be found particulars of several standard books on chemistry, published by the well-known firm of Longmans, Green and Company, Ltd., of 39, Paternoster Row, London, E.C.4.

The works on Inorganic Chemistry by J. W. Mellor, D.Sc., F.R.S., should find a same applies to the great Dictionary of Applied Chemistry, by Sir Edward Thorpe, C.B., Ll.D., F.R.S., the completion of the edition of which is announced.

Other books advertised are:—

"Recent Advances in Organic Chemistry," by Professor Alfred W. Stewart, D.Sc.

"Chemical Affinity," by L. J. Hudleston, M.C., B.Sc., A.I.C.

"Flame and Combustion Gases, by Prof. William A. Bone, D.Sc., Ph.D., F.R.S.

"The Higher Coal-tar Hydrocarbons," by Arthur Ernest Everest, D.Sc., Ph.D., F.I.C.

The Modern Calorimeter. By Walter P. White, Ph.D. (Physicist in the Geophysical Laboratory of the Carnegie Institution of Washington). American Chemical Society Monograph Series. Price $4. The Chemical Catalog Company, Inc., 419, Fourth Avenue at 29th Street, New York, U.S.A.

In some respects this is an unusual work, but none the less important, because it gives permanent record to experiments which are invariably set aside when they have answered the immediate purpose of the experimenters.

Experimental Researches and Reports Published by the Department of Glass Technology, University of Sheffield. Vol. X. 1927. Collected from the Journal of the Society of Glass Technology, Reports of the Progress of Applied Chemistry, and the Journal of the American Ceramic Society.

CORRESPONDENCE.

NUMERICAL RELATIONSHIP OF PROPORTIONS AND ASSOCIATED FIGURES.

(*To the Editor of the* Chemical News.)

Sir,

The numerical relationship involves the formation of two numbers. One of the numbers is formed by associating the first figures of several atomic weights to give a single atomic weight. The other number is the sum of the parts of the numbers so obtained. The original numbers represent, as far as possible, the same element on different systems of atomic weights. To the two numbers 2707 is added, and the procedure is as previously explained. The numbers are made the atomic weights of metals for the system on which 2707 is non-metal or *vice versa*. The resulting sum of products is directly related to the sum o fthe parts of the original numbers, if one of these num-

of 2707), which appears to canced out. The relationship is usually a whole number one; 2432, the atomic weight of magnesium frequently replaces the whole number relationship, for which reason it is termed a "Part." In the following instance the original proportion 2707 relates the two numbers.

The original number is 8654, Ag. The four numbers are as follows :— 5369413, 429031, 3261422, 6224079. The elements in the relationship are iodine, tellurium, selenium, gold and 2707 and bromine.

The sum of the parts of the atomic weights is 1154223 = 784811 + 369413 21.52 is Cu, 36.54 Ag. 1154224 + 2707 = 3861224. The latter number is equivalent to 114 exactly, referred to 2707/7992.

3861224 × 2707 = 1045234.

1045234 × 2909/6361 = 478001.

1045234 + 478001 = 5825244.

215189 × 2707 = 58252.

The precise conditions for obtaining always a direct whole number relationship are under investigation.

A. SAKOSCHANSKY.

26, Castle Boulevard,
Nottingham.

POWER STATION DEVELOPMENT *IN SOUTH AMERICA.*

Mr. F. H. Rosencrants, B.Sc., Engineering Director of International Combustion, Ltd., *Africa House, Kingsway, London,* W.C., who has recently been out to Central and South America in connection with "Lopulco" Pulverised Fuel interests, arrived back in England on May 2.

He indicates that there is a good deal of activity in connection with Power Station development throughout Latin America and that considerable expansion may be expected to take place within the very near future.

ROYAL INSTITUTION.

A general meeting of the Members of the Royal Institution was held on May 7, Sir James Crichton-Browne, Vice-President, in the chair. Sir J. J. Thomson was elected Honorary Professor of Natural Philosophy and Sir Ernest Rutherford was elected Pro*fessor of Natural Philosophy.* Miss Ingham, Mrs. Paul and Cuthbert Johnson were

FORTHCOMING EVENTS.

ROYAL INSTITUTION OF GREAT BRITAIN.

21, Albemarle Street, London, W.1.

Friday, May 18.—" The Sea in Fiction." By Morley Roberts. (Author of "Followers of the Sea," etc.)

ROYAL MICROSCOPICAL SOCIETY.

A meeting of the Society will be held in the Lecture Hall at the above address on Wednesday, May 16, at 7.30 p.m. The following papers will be read :—

"The Mode of Formation of the Image in the Microscope." By Dr. H. Moore, A.R.C.S., D.Sc., F.Inst.P.

"The Effects of Inanition and Vitamin 'B' Deficiency upon the Testes of the Pigeon. By Mr. G. F. Marrion, M.Sc., and Dr. A. S. Parkes, M.A., Ph.D., F.R.M.S.

"An Aberrant Ovary in a Frog." By Miss M. E. Shaw, M.Sc., and Dr. F. W. Rogers Brambell, B.A., D.Sc., Ph.D., F.R.M.S.

THE OPTICAL SOCIETY.

A meeting of the Optical Society will be held at the Imperial College of Science and Technology, Imperial Institute Road, South Kensington, on Wednesday, 16 May, 1928, at 7.30 p.m.

Thomas Young Oration, 1928.—By invitation of the Council, Professor G. W. Ritchey will deliver the Thomas Young Oration. Subject : "The Modern Reflecting Telescope." The Address will be illustrated by Lantern *Slides.* Professor Ritchey will describe two types : the Fixed Universal and the Compact Equatorial Ritchey-Chretien. He will give an account of his experience in making and using the great telescopes of Yerkes and Mount Wilson Observatories, and an account of the new cellular mirrors.

Members may introduce as many visitors as they please to this meeting, which will be *open to all who are interested* in this important subject.

ROYAL SOCIETY OF ARTS.

Wednesday, May 16, at 8 p.m.—Ordinary

THE ROYAL SOCIETY.

Burlington House, London, W.1.

Thursday, May 17, at 4.30 p.m.

UNIVERSITY OF LONDON.

University College, Gower Street, London, W.C.1.

Monday, May 14, at 5.30 p.m. — " Rossetti, the Poet." A public Lecture in commemoration of the centenary of his birth, by Dr. E. A. Baker.

Tuesday, May 15, at 5 p.m.—" Blood, a Study in General Physiology." First of a course of six public lectures by Professor Laurence J. Henderson, of Harvard University. May 15, 17, 18, 22, 24 and 25.

Chairman at the first lecture : Professor A. V. Hill, F.R.S.

Wednesday, May 16, at 5.30 p.m.—" The Ecclesiastical Jurisdiction of England in the XVIth, XVIIth and XVIIIth Centuries." A public lecture by Professor Walter Ashburner, D.C.L., of the University of Oxford, Fellow of the College.

Chairman : The Dean of Arches, Sir Lewis Dibden, D.C.L.

Thursday, May 17, at 5.30 p.m.—" Nel Centenario di Ferdinando Galiani." A public lecture in Italian by Dr. C. Pellizi.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

11,675.—Franklin, R. G.—Production of methanol, etc. April 20th.

11,717.—I. G. Farbenindustrie Akt.-Ges. Regenerating active silicic acid. April 20th.

11,197.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of benzanthrone-peri-di-carboxylic acid, etc. April 16th.

11,198.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of hydroxythionaphthelenes. April 16th.

Specifications Published.

265,986.—Geigy Akt.-Ges., J. R.—Manufacture of acid dyestuffs of the

271,837.—Etablissements Poulenc Freres.—Manufacture of readily soluble organic salts of c-c-dialkyl and arylalkyl barbituric acids.

288,884.—Gubelmann, Dr. L., Weiland, Dr. H. J., and Stallman, Dr. O.—1-amino-2, 4-dichloro-anthraquinone, and a process of making the same from M-dichloro-benzene and phthalic anhydride together with the intermediate products of such process.

277,372.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of 1-methyl-2 : 5 : 6 - trichloro - 3 - aminobenzene - 4 - sulphonic acid.

282,409.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of acid wool dye-

Abstract Published.

286,172.—Potassium carbonate and other salts.—Bregeat, J. H., 24, Rue de la Fidelité, Paris.

Hydrochloric acid; silica. — Potassium chloride is converted into potassium silicate with liberation of hydrochloric acid by heating with silica. The silicate is dissolved in water and treated with carbon dioxide to yield potassium carbonate and precipitate silica, which is used again. The carbonate may be treated to yield other salts either with an acid, for example sulphuric acid to yield potassium sulphate or by double decomposition, for example with calcium nitrate to yield potassium nitrate. The heating of the chloride with silica is effected in an electric or other furnace, and charcoal may be added to facilitate the subsequent solution in water.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

ODISKO.

488,421.—Dyes included in Class 1.—William Graham Nelson and Gilbert James Steven Wilson, trading in copartnership, 15a, Fairley Street,

REDOLEM.

489,285.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—Murphy & Son, Ltd., The Cedars, Sheen Lane, Mortlake, London, S.W.14. April 18th.

DAKRYSOL.

486,787.—Chemical substances prepared for use in medicine and pharmacy.—Franz Sigmund, Neue Weinsteige 160, Stuttgart, Germany. April 18.

BIOLITH.

488,743.—Chemical substances prepared for use in medicine and pharmacy.—Societe Anonyme la Biotherapie, 140, bis Rue Lecourbe, Paris, France. April 18th.

GITAINE.

489,307.—Chemical substances prepared for use in medicine and pharmacy.—Les Etablissements Poulenc Freres, 86 to 92, Rue Vieille-du-Temple, Paris, France. April 18th.

MACKECHNIE.

483,972.—Sulphate of copper for agricultural and horticultural use. — McKechnie Brothers, Limited, The Metal Works, Rotten Park Street, Birmingham. April 25th.

FACITE.

487,783.—Chemical substances used in manufactures, photography, or philosophical research, and anti-corrosives. — Lewis Berger & Sons, Ltd., 201, Morning Lane, Homerton, London, E.9. April 25th.

ELUXOLITH.

488,344.—Water softening preparations, being chemical substances in class 1, for use in water softening apparatus.—Electrolux, Limited, 153 & 155, Regent Street, London, W.1. April 25th.

ZEISSIKON.

486,430.—All goods in class 1 which includes acids, potash, salts and other chemical substances, used in manufactures. — Zeiss Ikon Aktiengesellschaft, Schaudauer Strasse 76, Dresden A. Germany. April 25th.

JUST PUBLISHED.

RASA-JALA-NIDHI

or Ocean of Indian Chemistry & Alchemy.

VOLS. I. AND II.

This is the most Comprehensive and Scientific Treatise on Hindu Chemistry, Alchemy and Medicine—a Science almost lost to Humanity several Centuries ago, and now reclaimed by

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THE CHEMICAL NEWS
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THE CHEMICAL NEWS

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CONTENTS. PAGE.

The Collinsics of Minerals 305
By Hawksworth Collins, B.A., (Camb.).
Alloy Steels, Their Manufacture, Properties and Uses 307
By H. C. H. Carpenter, M.A., A.R.S.M., F.R.S.
The Budget and Smoke Abatement ... 310
Chemistry and Industry 311
General Notes 311
London's War on Smoke 311
Proceedings & Notices of Societies:—
The Royal Society 313
Society of Glass Technology 314
Society of Public Analyists 315
Royal Agricultural Society 316
The Faraday Society 317
Notices of Books 318
Forthcoming Events 319
New Patents 319
New Trade Marks 320

UNIVERSITY OF LONDON.

A Course of Three Lectures on
"CHEMICAL KINETICS"
will be given by
PROFESSOR MAX BODENSTEIN
(Professor of Physical Chemistry in the University of Berlin) at UNIVERSITY COLLEGE, LONDON (Gower Street, W.C.1.) on MAY 31ST, JUNE 1ST and 4TH, at 5.30 p.m. At the first Lecture the Chair will be given by Professor F. G. Donnan, C.B.E., F.R.S. (Professor of General Chemistry in the University).

Admission Free, Without Ticket.
EDWIN DELLER, *Academic Registrar.*

ASSISTANT CHEMIST REQUIRED in Works about twelve miles from Paddington. Must have absolutely sound experience in Metallurgical Analysis, including Special Steels and in the Analysis of Engineering Materials in general. State age, qualifications, experience and salary required to Box C.N.347, c/o Mitchell & Co., 1, Snow Hill, E.C.1.

THE COLLINSICS OF MINERALS.

By HAWKSWORTH COLLINS, B.A. (Camb.).

This is the first of a series of papers, which show exactly the mathematical connection between

(1) The atomic weights.

(2) The specific gravity of the pure substance.

(3) The relative volume of each atom.

(4) The refractive index of the molecule.

(5) The refractivity of each atom—

of every mineral of which the refractive index can be obtained.

Or the matter may be stated as follows:—The relationship of three series of experimental data, and of two series of constants of every translucent mineral (including all pure chemical substances) is demonstrated in this and the following papers, *viz.*—

(1) Atomic weights, as observed by scientists, not including the investigator.

(2) The specific gravity of molecules, as observed by scientists, not including the investigator.

(3) The optical refractivity of molecules, as observed by scientists, not including the investigator.

(4) The relative volumes of the elements, as found by the investigator.

(5) The optical refractivity of the elements, as found by the investigator.

The Collinsics of twelve minerals are here presented to scientists, not for the purpose of asking them if they are correct, for that is evidently unnecessary, but merely as a gift.

Since something which is obviously true cannot have been built up from something which is not true, therefore the whole of the logical generalisations, laws, etc., which have been published by the *Chemical News* during the last twenty-two years in about sixty papers, and, which are all parts of a whole, are true.

The first of these twelve minerals will now be taken as an example of all.

11.865 has frequently been demonstrated in the *Chemical News* during the last ten years to be the relative volume of Na when in combination with other elements, and 15.085 to be that of Cl.

If the sum of these two be divided into the molecular weight of NaCl the result is 2.17

which lies between several experimental results, of which only the two nearest are given.

If the molecular volume is multiplied by $\mu - 1$, where μ is the Refractive Index of the substance, 14.685 is obtained, which splits up into 3,865 and 10.82. These are the optical refractivities of the two atoms Na and Cl respectively. And in every mineral whenever the volume of the Na-atom is 11.865 its refractivity is 3.865, and whenever the volume of the Cl-atom is 15.085 its refractivity is 10.82.

Similar remarks hold for all minerals.

So the word " Collinsics " is employed, until a better is found, to denote the ascertained relationship between thousands of experimental data in such a way that the matter is intrinsically proved to be true, and also in such a way as to gradually demonstrate new truths.

The more atoms there are in a molecule, the more certain is the truth. *E.g.*, in the last of the twelve minerals given below there are *ten atoms.* There are *six relative* volumes between the brackets, and each one of these has a corresponding and invariable *refractivity in all minerals in which it* occurs. If the molecular volume be divided into the molecular weight, the result is the correct S.G. of the pure substance, all impurities having been eliminated by the method. If the molecular volume be multiplied by $\mu - 1$, the result is a number which is the sum of the atomic refractivities.

These six atomic relative volumes were discovered 17 years ago, and have frequently been demonstrated in the *Chemical News* to be true in many ways.

TABLE I.

THE COLLINSICS OF TWELVE MINERALS.

		Theor. Column	Obs. Column	
(1) Rock Salt Na + Cl	S.G.	**2.17**	2.1881	Zehn
14.685 = 0.5449(11.865 + 15.085)			2.164	Beds
	R.I.	**1.5449**	1.5442	Dana
14.685 = 3.865 + 10.82				
(2) Sylvite K + Cl		**1.994**	1.994	Filh
18.31 = 0.49(22.29 + 15.085)		**1.49**	1.49	Miers
18.31 = 7.49 + 10.82				
(3) Fluorite Ca + F_2		**3.08**	3.086	Schr
			3.01—3.25	Dana
11.04 = 0.435(14.54 + 5.42_2)		**1.435**	1.4342	Dana
11.04 = 10.52 + 0.26_2				
(4) Natron, $Na_2CO_3.10H_2O$		**1.469**	1.46	Dana
Na_2 + C + O_3 + $10H_2O$				
81.740 = 0.42(11.865_2 + 8 + 7.53_3 + 14.03_{10})		**1.42**	1.405—1.44	S
81.745 = 3.865_2 + 3.333 + 1.654_3 + 6.572_{10}				
(5) Corundum Al_2 + O_3		**3.979**	3.979	15°.5 Chur.
19.68 = 0.7713(9.05_2 + 2.51_3)		**1.7713**	1.7682	Dana
19.768 = 7.865_2 + 1.346				
(6) Calcite, $CaCO_3$ Ca + C + O + O + O		**2.700**	2.702	Hoch
			2.6987	Kars
18.600 = 0.5023(14.54 + 8 + 7.53 + 4.45 + 2,51)		**1.5023**	1.48625	Dana
			1.65849	Dana
18.60 = 10.52 + 3.333 + 1.654 + 1.747 + 1.346				
(7) Gibbsite, $Al(OH)_3$		**2.304**	2.3	Dana
Al + O_3 + H_3				
19.740 = 0.583(9.05 + 2.51_3 + 5.76_3)		**1.583**	1.566—1.587	S.
19.742 = 7.865 + 1.346_3 + 2.[illegible]13$_3$				

(8) Topaz, $2AlOF.SiO_2$	**3.54**	3.52—3.56	Koks
$Al_2 + F_2 + Si + O_4$			
$\mathbf{33.166 = 0.6378(9.05_2 + 5.42_2 + 13.02 + 2.51_4)}$	**1.6378**	1.63747	Dana
$\mathbf{33.164 = 7.865_2 + 0.26_2 + 11.53 + 1.346_4}$			
(9) Cyanite $Al_2 + Si + O_5$	**3.64**	3.661	Erdm
		3.62	Miers
$\mathbf{32.240 = 0.72483(9.05_2 + 13.83 + 2.51_5)}$	**1.72483**	1.712	S.
		1.728	S.
$\mathbf{32.24 = 7.865_2 + 9.78 + 1.346_5}$			
(10) Nephelite, $Na_2Al_2Si_2O_8$	**2,63**	2.63	Lore
$Na_2 + Al_2 + Si_2 + O_4 + O_4$			
$\mathbf{58.521 = 0.54171(11.865_2 + 9.05_2 + 13.02_2 + 7,53_4 + 2.51_4)}$	**1.54171**	1.5416	Dana
$\mathbf{58.520 = 3.865_2 + 7.865_2 + 11.53_2 + 1.654_4 + 1.346_4}$			
(11) Kaolinite, $Al_2Si_2O_7 2H_2O$	**2.59**	2.6	Clark
$Al_2 + Si_2 + O_2 + O_5 + 2H_2O$			
$\mathbf{56.153 = 0.5635(12.05_2 + 13.02_2 + 4.45_2 + 2,51_5 + 14,03_2)}$	**1.5635**	1.561—1.565	S.
$\mathbf{56.154 = 4.863_2 + 11.53_2 + 1.747_2 + 1.346_5 + 6,572_2}$			
(12) Leutic, $KAl(SiO_3)_2$	**2.494**	2.48	Ramm
		2.519	Bisc
$K + Al + Si_2 + O_2 + O + O_3$			
$\mathbf{44.506 = 0.5091(22.29 + 12.05 + 13.02_2 + 7.53_2 + 4.45 + 2.51_3)}$	**1.5091**	1.509	Dana
$\mathbf{44.506 = 7.49 + 4.863 + 11.53_2 + 1.654_2 + 1.747 + 1.346_3}$			

H_2O which occurs in two of the twelve minerals is as follows:—

Crystallised Water.

	$H_2 + O$	
Relative Volumes ...	$5.76_2 + 2.51$	$= 14.03$
Atomic Refractivities	$2.613_2 + 1.346$	$= 6.572$

The Refractive Indices are always those given for Sodium light.

The Theoretical Refractive Index is always that R.I. of the atom, which it has when undistorted by the pressure of adjacent atoms.

The Theor. S.G. is always calculated at 15° C.

There is no room for more than the first four letters of observers' or recorders' names. S stands for "Smithsonian Publication."

The atomic weights are taken as whole numbers in every case, except that of Cl. This is recognised now by scientists to be a mixture of two elements of atomic weights 35 and 37 in the proportion of 3 : 1, so that its at. wt. is taken as 35.5. Br is also now recognised by scientists to be a mixture of two elements of at. wts. 79 and 81 in equal proportions, so that the at. wt. is taken as 80. Cl and Br are the only elements whose structures cannot be deduced from their relative volumes, and the reason for this is evident from what has just been said.

The thick type represents the discovery; the ordinary type gives the experimental data (of other scientists), which led to the discovery.

ALLOY STEELS — THEIR MANUFACTURE, PROPERTIES, AND USES.

By H. C. H. CARPENTER, M.A., A.R.S.M., F.R.S.

Professor of Metallurgy, Imperial College of Science and Technology.

TUNGSTEN STEELS. CHROMIUM STEELS. MANGANESE STEELS.

Mushet's air-hardened steel, which was the first of the alloy steels, is generally considered to be a simple tungsten steel. In addition to 6 per cent. of this metal how, ever it also contained about 2 per cent. of manganese and 2 per cent. of carbon. The manganese was required to give the steel the *self hardening* property. Actually, therefore, it was a quaternary steel. Special interest attaches to it in view of the fact that it was the pionner among alloy steels. It had a remarkable career of usefulness and formed an indispensable link in the

Influence of Tungsten on the Melting Points and Inversions of Steels.

Iron melts at 1535°C. The addition of carbon lowers the melting point about 100°C. for every 1 per cent. addition of carbon. Tungsten melts at 3267°C. and as previously mentioned is the most refractory metal known. It is generally considered that it lowers the fusion point of steel. Mars has given a table of the fusion points of tungsten steels ranging from 0.5 pr cent to 17 per cent. tungsten from which he has drawn his conclusion. If, however, his results are corrected for the lowering effects of the carbon, silicon and manganese present in the steels, some doubt arises as to whether this conclusion is correct. Thus a steel which contained 0.66 per cent. carbon, 0.3 per cent. silicon, 0.04 per cent. manganese and 3.11 per cent. tungsten fused at 1488°C. The carbon would lower the fusion point about 60° C., and the effect of the silicon and manganese would be inappreciable so that the plain iron tungsten alloy should fuse at about 1548° C., which is 13° above that of pure iron. This appears to be the effect of 3.11 per cent. of tungsten and it is not a lowering but a raising of the fusion point. Considering the refractoriness of tungsten, it may well be doubted whether it does really lower the fusion point of iron.

There is no doubt, however, that tungsten does lower the pearlite inversion in carbon steels when they are heated to a sufficiently high temperature. More than 20 years ago I showed that whereas the temperature of this change was about 700° C. in a steel containing 0.63 per cent. of carbon and 10.56 per cent. of tungsten when cooled from 1000° C. at a slow rate, it had dropped to about 550° C. when the same steel was cooled from 1200° C. Moreover, whereas the change completed itself within about 10° when the steel was cooled from 1000°, it was spread over about 100° C. when it was cooled from 1200° C. Interpreting these figures in the light of the work of Arnold and Read, it is clear that when the steel was not heated above 1000° C., iron carbide Fe_3C separated at the normal temperature of about 700° C. When it was to 1200° C., however, a mixture of iron carbide and tungsten carbide began to separate at 550° C., and continued to crystallise down to about 450° C. Tungsten carbide is not formed until the steel is heated to the neighbourhood of 1200° C. It then produces a lowering of the change point of from 150° C. to 250° C.

Manufacture of Tungsten Steel.

Tungsten steel is nearly always made by crucible process. The world's production of alloy steel in 1925—7,217 tons—represents probably the tungsten steel manufacture of that year. Special care is required in charging the pots owiug to the great deifference between the specific gravity of tungsten (19.3) and of steel (about 7.6). The tungsten is placed at the top of the charge and is gradually dissolved by the steel which melts long before it. If the tungsten were originally placed at the bottom of the crucible an infusible mush of rich tungsten alloy would form, which would neither pour out nor mix with the steel. Special care, therefore ,is needed to get the mtungsten melted and evenly dissolved. After melting, the steel is " killed " in the crucible by holding it in the furnace for at least 30 minutes. The contents may be cast either singly or douhly by handpouring or collectively hy means of a ladle into which the contents of the pots are emptied. As a rule tungsten steel makes very sound solid ingots, though considerable piping takes place. It seems doubtful, owing to its low heat of combustion, whether tungsten aids in deoxidising the steel. Its heat of combustion is about 1000 calories, whereas the burning of iron to Fe_3O_4 yields about 1600 calories. The heating, forging, and rolling of tungsten steels does not present any special problems or difficulties, and the processes adopted are similar to those employed with other high carbon steels.

Properties and Uses.

Plain tungsten steel is principally used in virtue of the magnetic qualities which it can be made to possess. It finds application in permanent magnets for electric meters, in small dynamos and for hand use. By far the greater part of the annual production consists of a steel containing about 6 per cent. of tungsten and from 0.6 per cent. to 0.75 per cent. of carbon. To obtain the best magnetic qualities it must be heat-treated and therefore all magnet steels are used in this condition. The process involves two operations (1) the steels are hardened by heating and quenching, (2) they are then magnetised, and if they are to be used for electric meters they are " seasoned " by a protracted heating at 100° C. so as to make their magnetism as nearly constant as possible. I am indebted to Dr. W. H. Hatfield for the following data relative to the heat and magnetic treatment of these steels. They are quenched in water from 850° C. and are used in this condition. The coercive force obtained depends largely upon the

carbon content as is shown in the following table :—

Tungsten per cent.		Carbon per cent.		Coercive force
6	...	0.60	...	58
6	...	0.65	...	63
6	...	0.70	...	68
6	...	0.75	...	72

MAGNET STEELS OF OTHER COMPOSITIONS.

A variety of other alloy steels have been proposed for magnet steels, *viz.*, chromium-tungsten, chromium-cobalt, and cobalt-chromium steels. The following values have been furnished me by Dr. Hatfield as having been obtained with steels containing 1 per cent. of carbon and 1.4 per cent. chromium.

Treatment.	Coercive Force	Reman-ence
Water quenching 860° C	65	9000
,, ,, 820° C	64.5	9850
,, ,, 780° C	61	10310

The addition of from 0.75 per cent. to 1 per cent. of chromium to a 6 per cent. tungsten steel appears to increase the coercive force slightly without seriously affecting the remanence. Evershed (*loc. cit.*) considers that the addition of chromium renders the material more liable to the effect of spoiling, but this matter does not yet appear to have been so thoroughly investigated as has been the case with tungsten steels. Cobalt magnet steel discovered by Honda and Takagi in 1917 contains essentially from 30 per cent. to 40 per cent. of cobalt with from 0.4 per cent. to 0.8 per cent. of carbon in the steel. In their patent specification, however, they extend the cobalt range to from 20 per cent. to 60 per cent. They also give from 3 per cent. to 9 per cent. of tungsten and from 1.5 per cent. to 3 per cent. of chromium. The most suitable heat treatment for this steel is an oil quenching from 950° to 1000° C., when it is endowed with a coercive force of from 220 to 250, together with a remanence of the order of 10,000. On account of the high coercive force, however, magnetisation is difficult, and it is necessary to use very high magnetising fields (1400 c.g. units) in order to obtain saturation and the high figures of remanence and coercive force quoted. Since the discovery of cobalt magnet steels, many patents of steels containing carying amounts of cobalt with additions of other elements have been taken out. Among them may be mentioned those of Hadfield in this country, Krupp in Germany, and Sumitomo Chukosho in Japan. These cover a very wide range of composition and properties. According to Kayser, steels of the composition chromium 9 per cent. to 15 per cent., cobalt 1 per cent. to 18 per cent., and carbon above 1 per cent. are air hardening. The compositions quoted have been arrived at empirically by experiment. The explanation of their action must await proper scientific investigation.

CHROMIUM STEELS.

Plain chromium steels were some of the earliest alloy steels to be made. They were used for a variety of purposes, in all of which,, however, the property of hardness was an important factor. These uses date from about the year 1880. It is very remarkable that an entirely new use for chromium steels was discovered more than 30 years later, particularly as the literature of the last 20 years of the 19th century and the first 12 years of the 20th century contains many references to the preparation and properties of chromium steels. Mention may be made of the extensive researches of Sir Robert Hadfield in this country and Messrs. Guillet and Portevin in France, into the properties of chromium steels, but neither of these investigators nor any others up to 1923 discovered that high chromium steels, when suitably heat-treated, were remarkably resistant to corrosion. This particular discovery was made by Mr. H. Brearley in 1913 and was, as is often the case, a chance discovery. It has resulted in the production and manufacture of the numerous varieties of "stainless" steels which are now on the market. So rapid and important have been the manufacturing developments that have followed on Mr. Brearley's discovery that the corrosion and staining-resistant properties of heat-treated chromium steels now constitute the most important application of this alloy metal.

INFLUENCE OF CHROMIUM ON THE MELTING POINTS AND INVERSIONS OF STEEL.

The melting points of iron and chromium are almost the same. That of iron is 1535° and that of chromium is 1525° C. Chromium accordingly has very lttle effect on the melting point of iron. The two metals mix readily in the liquid state and they have the same crystal lattice (a body-centred cube). There is little doubt that these are favourable factors in producing the valuable properties which chromium steels possess.

MANUFACTURE OF CHROMIUM STEELS.

The production of plain chromium steel ingots in 1913 was probably about 6,000 tons, with a content of chromium of from 0.4 per cent. to 2 per cent. They were made either by the acid open-hearth or the crucible process. Stainless steels contain

considerably more chromium, viz., from 12 per cent. to 20 per cent. or even higher, are generally manufactured in the electric furnace. When made in crucibles the chromium, added in the form of ferro-chromium, was a part of the original charge. When manufactured in the open-tearth furnace, however, the ferro-chromium was added just long enough before casting for the alloy to be melted and well mixed with the charge. Mr. Hibbard estimates that the consumption of ferro-chromium for steel making in the U.S.A. in 1913 was between 3,000 and 4,000 tons, containing from 60 per cent. to 70 per cent. of chromium. Assuming an average content of chromium of 1 per cent. in the structural steels and 4 per cent. in the high-speed tool steels, he estimated a total production of 204,000 tons of steel of all kinds containing chromium. It is quite certain that at the present time the output is considerably larger in view of the great development of stainless steels for a variety of uses.

At steel-melting temperatures chromium has a greater affinity for oxygen than has iron. If, therefore, ozygen either free or in the form of oxide of iron, comes in contact wth melted steel containing chromium, some of the chromium is wasted by oxidation. This is the reason why in the manufacture of steel in the open-hearth furnace the ferro-chromium is added at the latest possible stage of the melting. Chromium steels can be cast, forged and worked by the same plant, and the same methods, as carbon steels of the same or slightly higher carbon content. The effect of adding chromium up to a maximum of about 2½ per cent. in steel is to increase the hardness moderately when the steel is in the unhardened state. The hardening effect is much greater, however, when the steel is quenched, and practically all chromium steels are used in the heat-treated condition in order to get the full value of the presence of this element.

(To be Continued.)

THE BUDGET AND SMOKE ABATEMENT.

One aspect of the Budget which seems to have been overlooked is its potential effect upon the Smoke Abatement problem. It is now generally accepted by the fuel experts that the new fuel tax of 4d. a gallon, from which home-produced motor spirit and light oils are exempted, will give a decided stimulus to low temperature carbonisation of coal, the by-products of which include *inter alia* about 15 gallons of oil per ton.

This will necessarily lead to an increased value for such by-products, and it is reasonable to expect that the confidence of coal owners, gas companies and other industries in the commercial prospects of coal distillation will be strengthened. It is therefore probable that in the near future we shall see the erection of a number of new low temperature carbonisation plants with a resultant increase in the available supplies of solid smokeless fuel suitable for burning in domestic grates. This appears to offer a unique opportunity for local authorities to address themselves towards the solution of the domestic smoke problem both by actively encouraging through educational means the burning of smokeless fuel instead of raw coal, and by the production of such fuel in conjunction with municipal gas undertakings, as is now being done by the Glasgow Corporation.

It is rather a happy coincidence that the Budget synchronises with the completion of arrangements between the Government and a leading London gas company for the erection of a low temperature carbonisation plant. It is obvious that the reserved attitude of the gas industry towards the distillation of coal under low temperatures has been dictated not by lack of enterprise or by prejudice, but solely by commercial considerations. The gas industry has, of course, made an enormous contribution towards smoke abatement by evolving economical, hygienic and efficient gas fires and gas cookers. But, despite the attractiveness of these appliances, raw coal burning still constitutes the principal means of heating and cooking in the homes of the workers. It is, therefore, apparent that gas companies will now be able to exploit entirely new markets for solid smokeless fuel, for which they already have the distributing organisation, without in any way competing with the demand for gas fires and gas cookers.

Is it too much to hope that the Budget will create new orientation of the problem of low temperature carbonisation which will enable local authorities, gas companies and the coal industry all to co-operate? I trust that early proof will be forthcoming that the petrol and oil preference will justify an early large scale development of the scientific treatment of our coal resources, and will sppedy the day when the smoke pall over our great cities will be dispersed.

CHEMISTRY AND INDUSTRY.

CONFERENCE IN LONDON, MAY 11 TO 15.

Designed to show the world the progress already made by British Chemical Industry as well as to outline new directions of endeavour, the Conference of the Society of Chemical Industry being held in London will demonstrate conclusively the success of British workers in new fields, and do much to allay the suspicion held in certain quarters that British enterprise is lacking in experimental research work and in the application of discoveries to the advancement of British Industry.

Sir Phillip Cunliffe-Lister, President of the Board of Trade will propose the Toast "The British Chemical Industry" at the dinner to be held on Monday, May 14, in connection with the Conference, and will be replied to on behalf of the Industry by Sir Alfred Mond, P.C., M.P., and Sir David Milne Watson.

The wide scope of the Conference can be gathered from the following brief particulars.

Sir Alfred Mond will give an address on the subject he has made particularly his own—the application of scientific research to industry. Sir Arthur Duckham, K.C.B., will speak hopefully on the future of the coal industry in view of the work of the Chemical Engineer in its proper utilisation. The marvellous success in the fixation of nitrogen and the provision thereby of nitrogen for fertilisation in unlimited quantities, will be demonstrated by Lieut.Col. Pollitt, D.S.O. Professor G. T. Morgan, F.R.S., will tell the Conference the results of chemical study of low temperature tar.

It is the practice of the modern industrial chemist to work towards a definite objective. He finds that a given industry needs a new impetus, and he sets about discovering it. He investigates every process already available, notes the failure of some, the partial success of others. He finds the causes of failure and the weakness of partial success, and out of them he produces the perfect article that is required.

We see the results of his work in every direction—in buildings, in paper, in rubber, in clothes, in food, in medicine, in transportation, in our streets, our homes, our persons. He is busy all the time, working for the ideal of conservation of valuable material, so that the utmost benefit may be secured for human use of all the products of nature and the fullest value obtained from the processes of manufacture.

GENERAL NOTES.

LONDON'S WAR ON SMOKE.

SOUTH METOPOLITAN GAS COMPANY'S HELP.

The perfection of an open grate that will enable ordinary gas coke to burn with a glowing flame and without emission of smoke was announced by Mr. Frank H. Jones, Vice-President of the South Metropolitan Gas Company, to members of the Metropolitan branch of the Society of Medical Officers of Health, who visited the Company's works on Friday, May 4.

Mr. Jones said that smoke abatement was undoubtedly the question of the hour. A Canon of St. Paul's had recently made the astounding statement that the encrustation of black soot on our ancient buildings was actually a protection for the fabric of such buildings. "Such a statement," he said, "sets the whole profession of chemists laughing and brings tears to the eyes of architects and builders. But it is not calculated to assist the task of either Medical Officers or gas companies in the fight for purer air."

The Budget also was claimed to offer encouragement to the scientific treatment of coal. While he would not comment on the large-scale experiment in producing smokeless fuel to be tried by one of the leading gas companies in London, he wished to draw attention to the remarkable results which had been achieved by the research laboratories and the designing staff of the South Metropolitan Gas Company in the matter of smokeless fuel.

BRIGHTER COKE.

"We have," he said, "during recent months perfected an appliance which, in effect, solves the whole problem of making gas coke burn brightly with a lively flame in the open grate. This appliance takes the form of a specially designed grate, the secret of which lies in its complete insulation and in the draughts which ensure the maintenance of a wonderful state of incandescence throughout the burning period. The coke is lighted in the first instance by a gas burner attachment, and the grate is so designed that it can be easily and cheaply fitted to an ordinary chimney. It is now available to the public on ordinary cash terms, hire purchase or simple hire."

This invention, he claimed, meant cheaper cleaner smokeless fires to the hundreds of thousands of people resident in the 52 square miles of Greater London served by the South Metropolitan Company. The

Company actually produced 750,000 tons of coke in a year. He trusted that the Metropolitan Medical Officers of Health would, in the course of time, see evidence of the success of smokeless fires in a new London of blue skies, clear air and bright sunshine.

RADIUM FIND IN ONTARIO.

Activity in connection with the development of radium deposits in Haliburton County, Ontario, were foreshadowed in a recent address before members of the Canadian Progress Club at Toronto. The pitchblende ore found in Haliburton County is stated to compare favourably with that of the Belgium Congo, and a company known as the Ontario Radium Corporation has been organised for the purpose of carrying on mining.

CANADIAN GYPSUM PRODUCTION, 1927.

According to the Preliminary Report of the Dominion Bureau of Statistics at Ottawa for the Calendar year 1927, a further advance was shown in the Canadian production of Gypsum last year, shipments having constituted a record over all previous years. The mineral is produced in Nova Scotia, New Brunswick, Ontario, Manitoba and British Columbia, and activities in British Columbia have resulted in large increases of production during the past wto years.

NOVA SCOTIA INFUSORIAL EARTH.

According to the "Canadian Mining and Metallurgical Bulletin" for April, 192, the Nova Scotia Technical College has inaugurated a special research into the natural properties of infusorial earth and the methods of treatment necessary to prepare the material for the market.

There are great deposits of this mineral in every part of the Province, and one of the largest of these is now being exploited by a Canadian company. Special apparatus has been purchased by the College for research work, and it is hoped that definite assistance may be given towards the establishment of a new industry in Nova Scotia.

BOARD OF TRADE ANNOUNCEMENT.

RADIUM.

The Treasury have made an Order under Section 10(5) of the Finance Act, 1926, exempting radium compounds from Key Industry duty from 15 May to 31 December, 1928.

The Treasury Order will shortly be published by the Stationery Office.

EUROPEAN TRADE NOTES.

FINLAND'S FOREIGN TRADE.

One of the most significant features in Finland's recent economic history is the continuous growth of the country's external trade. The increase in imports from the United Kingdom last year was encouraging, and, writes Mr. Cecil H. Mackie, British Consul at Helsingfors, there is every reason to hope that the small deficit remaining as compared with 1925, and which is present owing to the British coal stoppage of 1926, will be wiped off this year.

BRITISH TRADE WITH LITHUANIA.

Imports into Lithuania from Great Britain last year represented in value about 6¾ per cent. of the total. This could be increased, writes Mr. L. A. Parish, British Consul at Kovno, in his Report on Commercial, Financial and Economic Conditions in Lithuania, though prospects do not warrant the establishment of expensive organisation. There appear to be possibilities, however, of development through commission agents and local merchants.

GERMAN TRADE IN MARCH.

Imports in March last exceeded exports by 207.8 million marks, as against an excess of the former over the latter of 307.8 million marks in February. Exports rose by nearly 80 million marks, and reached the high total of 1,024.4 million marks.

FRENCH TRADE BALANCE.

An unfavourable balance of 211 million francs is shown for French foreign trade in the first quarter of 1928, whereas for the corresponding period of last year there was an excess of exports over imports amounting to 697 million francs.

BRITISH MIGRANTS.

The nett excess of British emigration over immigration during the twelve months ended with March, 1928, was 89,793 as compared with 114,166 in the preceding similar period. Considerable decreases are shown in the net migration to New Zealand, Australia, British North America and the United States.

CZECHOSLOVAK FOREIGN TRADE.

The foreign trade balance of Czechoslovakia during March was favourable to the extent of 68,953,000 crs., and for the first quarter of the year, 297,223,000 crs. In 1927 the respective totals were 220,875,000 crs., and 849,668,000 crs.

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.

On Thursday, May 10, at 4.30 p.m., the Croonian Lecture was delivered on :—

Certain Problems in the Physiology of the Cerebral Hemispheres. By PROF. I. P. PAVLOV, For.Mem.R.S.

The following is an abstract :—

The function of the nervous system is to maintain dynamic equilibrium within the organisation and between the organism and its environment. In the latter case the equilibrium is, in the higher animals, extremely complex and is achieved mainly by means of the hemispheres. These continuously analyse and synthesize events occuring in the environment, and in correspondence with its changes establish temporary connections between events, whether simple or complex, and various activities of the organism, in particular those of the skeleto-muscular system which is preponderantly concerned in reacting to environmental changes and is likewise itself highly differential and integrative in its response.

At present the physiology of the hemispheres exists only in outline—as a framework consisting of only a limited number of kuown factors, such as excitation and inhibition, their two-directional movement in the form of irradiation and concentration, and their mutual inducton. The working out of the innumerable details of their intimate mechanism is a colossal problem of the future. At present in this respect we do but collect fragmentary observations, a small part of which, comprising the latest investigations carried out by the author and his co-workers (i.e., subsequent to the publication of the author's book, " Conditioned Reflexes ") are given here in summarised form.

(1) The development of new temporary connections between external agencies and definite reactions of the organism (development of conditional reflexes) depends on the coincidence in time of the action of these agencies upon the receptor mechanisms of the organism with the various activities of the organism evoked either by external stimuli effective since birth, or by external stimuli which have become established as such after birth, or finally by changes in the internal condition of the organism (automatic stimuli). Under these conditions the formation of the connection is a physiological law.

In order to become firmly established, powerful, conditioned stimulus the external stimulus *must* begin to act slightly before the particular activity of the organism, and *may* even cease a few seconds before the beginning of the activity. If, on the other hand, the given activity constantly begins before the stimulus, either no connection is established or if any is established it is weak, and survives only for a short time, and the specialised excitatory effect of the stimulus is invariably replaced by general inhibition. The biological significance of this fact is not yet clear. Where the stimulus begins to act before the given activity of the organism and continues during that activity the reflex tends to increase in strength and stability.

The mechanism underlying these phenomena cannot be expressed in terms of the general properties of the cortical tissue without further investigation.

(2) The analysing activity of the nervous system is founded in the first instance on the peripheral receptor organs, which constitute not only a receptive mechanism but also an analysing apparatus of the organism. To the peripheral points of the analyser separate points correspond in the cortex (the primary and simplest cortical mosaic). A good proof of this is that by applying definite external stimuli belonging to the same analyser, *e.g.*, different auditory stimula, it is possible to produce various disturbances or fatigue at different strictly localised cortical points. In this manner a very delicate method is opened up for investigating the construction of the cortical parts of the analysers, and it is possible to distinguish special areas in the cortex corresponding to the different analysers (visual, auditory, etc.) from certain other cortical elements of those analysers, which are dispersed probably over the whole mass of the cortex of the hemispheres. Not only are these dispersed elements incapable of performing any higher synthesis and analysis, but they have a very low degree of vitality, as evidenced by the rapidity of their transition into an inhibitory state under the influence of external stimuli.

(3) The conditions determining the characteristics and the magnitude of the excitatory and the inhibitory effects of conditional stimula are bewilderingly complex and are only gradually being registered and classified.

It is obvious that the magnitude of the positive effect is directly related to the amount of energy applied to the receptor organ. The phenomenon of summation of weak stimuli comes out clearly. The limit

of normal excitability and the optimum strength of stimulation are also definite. In the case of very strong stimuli and of the summation of medium stimuli the excitatory process rapidly changes into an inhibitory one. Of course the strength of stimulus is a relative quantity, varying greatly with individual differences of nervous system.

Since most probably the points between which the uew connections are established are in the cortex, it follows that the variations in the effect of conditioned stimuli will be dependent on the mutual relation between the different cortical poiuts corresponding to the different conditioned stimuli, and also between the different points of those areas of the hemispheres which are affected by the unconditioned stimulus. For instance, the conditioned stimuli based on food and acid respectively, both become connected with the chemical analyser of the hemispheres and therefore, if in the experiments both sets of conditioned stimuli are used, their effect will be determined not only by the inter-relation of tbe points corresponding to the stimuli, but also by the relation existing between the alimentary and "acid" points of the chemical analyser.

(4) The accumulation of observations upon the normal and pathological activities of the hemispheres gives grounds for distinguishing various types of nervous system. There is the excitable type, which always displays partial or complete failure when confronted by difficult relations between the excitatory and inhibitory processes, and which, if the experiments are continued, ends by developing an abnormal and extremely protracted weakening of the inhibitory activity, attended by an exaggerated general excitation. At the other extreme stands the inhibitable type, which very easily becomes subjected to inhibition by stimuli either unusual or slightly stronger than usual, and which when confronted by comparatively difficult relations between the excitatory and inhibitory processes passes into a state of complete inhibition for prolonged periods of time.

In between can be placed the well-balanced type which, successfully and without any signs of abnormality, establishes in all cases a balance between the opposed nervous processes. This type comprises two varieties of animal, differing greatly from one another in external appearance—the stolid animal, always quiet, and the animal which is lively under ordinary conditions, but becomes drowsy with surprising rapidity under monotonous conditions. The latter variety has some difficulty in obtaining a balance between the two processes. This grouping of the types of nervous system corresponds closely to the ancient classification of temperaments; the excitable type — choleric temperament; the inhibitable type —melancholic; the quiet, balanced type—phlegmatic; the lively balanced type—sanguine.

SOCIETY OF GLASS TECHNOLOGY.

The President, Mr. W. Butterworth, Senr., M.A., occupied the chair at the meeting of the Society of Glass Technology held in Sheffield on April 18. The following paper was communicated :—

Some New Facts Arising from a Study of the Casing of Colourless by Coloured Glass. By S. ENGLISH, D.Sc., F.I.C., PROF. W. E. S. TURNER, AND F. WINKS, M.Sc., Tech.

Professor Turner presented an account of work which had been proceeding for three to four years in the Department of Glass Technology.

Three series of glasses had been employed, the one being soda-lime-silica glasses coloured by cobalt oxide up to 0.49 per cent. The second consisted of potash, -lead oxide-silica glasses coloured by cobalt oxide up to 0.9 per cent.; while the third series consisted of commercial soda-potash-lead oxide-silica glasses, colourless, ruby, green and blue.

The coefficients of expansion of these glasses were determined by a differential method of great reliability the results being plotted graphically against temperature over the range from 0° to the upper annealing temperature. It was found that in the first series of glasses the greatest difference produced by the addition of 0.49 per cent. of cobalt oxide in the expansion up to the lower annealing temperature was not greater than 3 per cent., while the maximum displacement of the lower and upper annealing temperatures was of the order of 5°. Hence, no difficulty should be found in welding any of these glasses.

With the second series of glasses it was found that the expansion did not differ appreciably up to the lower annealing temperature, but this temperature was displaced progressiyely upwards, the displacement reaching some 25° for the glass containing 0.9 per cent. cobalt oxide, as compared with the parent glass. Similar displacement of the lower annealing temperature was found in the series of commercial glasses. It was found to be possible, experi-

mentally to weld any of the glasses successfully.

The rate of setting, and the effect of radiation were investigated for the soda-lime-silica and potash-lead oxide-silica glasses, while the viscosities were also determined over a wide temperature, range for the former series. When worked commercially the blue glasses set more rapidly than the colourless one, yet the viscosities as measured in a closed vessel were not greatly different at any given temperature. The outer layers of the coloured glasses cooled more rapidly than the colourless, due to more rapid loss of heat by radiation.

A number of important principles were established including

(1) The rate of thermal expansion in some glasses, such as the soda-lime-silica, soda-potash-lead oxide-silica, and soda-iron oxide-silica undergoes changes, not only at the lower annealing temperature but also at one or more definite points below that temperature. Some series, however, such as the potash-lead oxide-silica series have constant thermal expansion coefficient up to the lower annealing temperature.

(2) In some glasses, especially lead oxide glasses, quite small amounts of colouring oxides appear to raise the lower annealing temperature substantially.

(3) Viscosity determinations in closed vessels do not necessarily afford a measure of the rate of setting of glasses worked under commercial conditions. This is specially true of coloured glasses. The rate of loss of heat from the outer layers either of radiation or by conduction must be taken in account.

SOCIETY OF PUBLIC ANALYSTS.

An ordinary meeting of the Society was held in the Chemical Society's Rooms, Burlington House, on Wednesday, May 2, the President, Mr. Edward Hinks, being in the chair.

Certificates were read for the first time in favour of Bhagwat Prasad Bhargava, B.Sc.; Cyril Ernest Gill; and Thomas Percy Hilditch, D.Sc., F.I.C.

Certificates were read for the second time in favour of Arthur Duncan Gay; John Gordon Mayne; Reginald Arthur McNicol, M.Sc., A.I.C.; William Ramsden Orrell, B.Sc., A.I.C.; Laurence Frederick Smith, M.Sc., A.R.C.S., D.I.C., A.I.C.; Charles Frederick Turner, F.I.C.

The following were elected Members of the Society: Frank Rowland Hill, B.Sc., A.I.C.; Edward Thomas Illing, B.Sc., F.I.C.; Farid Iskander; Harry Bulmer Marston, B.Sc., A.I.C.; Reginald James Munro, B.Sc., A.I.C.; John Ralph Nicholls, B.Sc., F.I.C.; H. Gordon Reeves, D.Sc., Ph.D., F.I.C.; George Walsh, B.Sc., A.I.C.; Ronald George Warren, B.Sc.; William Arthur Waygood, B.Sc., A.R.C.S., A.I.C.

The following papers were read and discussed :—

Locust Kernel Gum and Oil. By A. L. Williams, A.I.C. (Work done under the Analytical Investigation Scheme).

Locust kernel gum has recently been used as a thickening agent for sauces. An outline is given of the nature of the gum, and its reactions, as compared with those of gum tragacanth and other gums. The reactions with tannin, borax and Fehling's solution are the most characteristic. As little as 1 per cent. of the gum may be separated from sauce or jam by treatment with tannin.

The constants of the kernel oil have been determined (iodine value, 98.4). The oil gave a negative result in the antimony trichloride test for Vitamin A.

Investigations into the Analytical Chemistry of Tantalum, Niobium and their Mineral Associates. XII. Observations on the Pyrosulphate Hydrolysis Method. By W. R. Schoeller, Ph.D., and E. F. Waterhouse.

It is shown that the pyrosulphate hydrolysis method does effect a quantitative separation of the earth acids from zirconia. At best, a decrease in the quantity of zirconia co-precipitated is achieved, at the cost of slightly incomplete earth-acid precipitation. The hydrolytic precipitation of titania from acid sulphate solution, and of earth acids in presence of titania, is prevented by the presence of zirconia.

The Separation of Lead Tetra-Ethyl from Solution in Petroleum Spirit. By F. W. Toms, F.I.C., and C. P. Money, B.Sc., A.I.C.

The method depends on the separation of lead ethyl sulphinate on passing sulphur dioxide into " ethyl petrol," and conversion of the deposit into lead sulphate.

New Precipitation method of Determining Vanadium and its Application to Steel Analysis. By B. S. Evans and S. G. Clarke.

The method is besed on the precipitation of vanadium as ferrocyanide and eventual determination of the vanadium present by titration with potassium permanganate. Vanadium ferrocyanide is insoluble in mineral acids of quite high concentration. In applying the process to steel analysis the

iron is quantitatively converted into ferrocyanide by reducing it from the ferric condition in alkaline citrate solution in presence of cyanide, and the resulting ferrocyanide then acts as the reagent for the vanadium. Of the methods ordinarily met with in the analysis of steel, the only one likely to interfere with the process is nickel; this is removed beforehand by treatment with dimethylglyoxime.

The Examination of Liquorice Mass. By P. HOUSEMAN, Ph.D., F.I.C.

Standard methods of analysis and the method of stating the resuults of analysis are described in detail. In view of the fact that stick liquorice adulterated with starch is now extensively sold in England, a test to detect this adulteration has been devised. Occasionally the added starch is boiled so as to destroy the individuality of the granules, but usually it is possible to discover a few granules that have escaped disintegration.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

At the meeting on May 2, held at 16 Bedford Square, London, W.C.1., the Consulting Chemist (Dr. J. Augustus Voelcker, M.A.), presented his report which dealt with several subjects affecting agriculture.

Basic Slag. Delivery of unequal quality and nature.

A member of the Society resident in Hampshire bought 12 tons of basic slag from a London firm. It was guaranteed to contain 40/42 per cent. phosphates and to be of 80 per cent. "fineness," price 3 17s. 6d. per ton.

On arrival of the delivery the purchaser noticed that some 9 cwt. of the delivery was of different appearance to the bulk, and of this he sent me a sample, I finding it to analyse :—

Phosphates (total)	36.10 per cent.
Fineness	47 per cent.

This had neither the appearance nor possessed the distinctive properties of basic slag, being also but coarsely ground. It was, in all probability, some kind of mineral phosphate. The remainder of the delivery appeared to be genuine and was finely ground.

On the purchaser complaining, the vendors made the allowance I suggested, viz., 15s. 6d. per ton, in respect of the inferior portion.

Damaged Linseed Cake Meal.

A member of the Society living in Warwickshire sent me a sample of linseed cake meal, to know if it was suitable for feeding to calves and young stock. It had been guaranteed to contain 12 per cent. of oil and 29 per cent. of albuminoids, and the price was £11 10s. per ton. On analysis the sample gave :—

Oil	12.79 per cent.
Albuminoids	27.93 ,, ,,
Sand	1.93 ,, ,,

The cake, accordingly, came up to guarantee, though the sand was decidedly high. But the cake had a dark appearance and a smell as of having been heated. Moreover, it was distinctly acid and showed the presence of salt. It was, in all probability, cake that had got sea-damaged, and been subsequently dried by heat. Such damaged cake is not a proper food for stock, especially for young stock.

CHEMICAL SOCIETY OF JAPAN.

Papers communicated :—

Shinroku Mitsukuri and Seibi Toraishi : "On the Absorption Velocity of Carbon Dioxide Bubbles by Caustic Soda Solution."

Toshi Inoue : "A Spectroscopic Method for Detection of the Formation of Complex Salts. Part VI. Formation of Complex Salts between Mercuric Cyanide and Metallic Salts."

Giichiro Fuseya and Takeshi Kita : "Effects of Current Density and Time on Hydrogen Overvoltage of Chromium."

Eiichi Funakubo : "Studies on Indol-derivatives of Arsenic. Part VII. Nitration of Indol-β-arsonic Acid and the Preparation of 3 - Carboethoxy - indol - 6 - arsonic Acid."

Junzo Arima : "On a Glucoside in the Root of Pencedanum decrusvum Maxim. Part III. Constitution of Nodakenin.

Junzo Arima and Buyu Takahashi : "Studies on the Constitution of the Stem of Akebi quinata, *Decne.*"

Ietake Okada : "Chemical investigation of Japanese Minerals containing Rarer Elements. Part XV. In the Radium Content of Samarskite and Fergusonite."

Tamaki Nakasono : "On the Studies of Quantitative Analysis Using Bromine : Part III. Determination of Antimony and Arsenic by Means of Metallic Electrode."

Eiichi Iwase : "On the Effect of Mercaptan upon the Life of Colloidal Solution of Sulphur."

Tokuichi Tsumaki: "Reaction between 1, 4-Naphthylene Dimagnesium Dibromide and Benzophenone."

Seitaro Miyairi: "Synthesis of Some Derivatives of Carbamic Esters."

San-ichiro Mizushima and Takeo Aso: "Anomalous Dispersion and Absorption of Electric Waves. Studies on Benzyl Alcohol, Ethylene Glycol and Allyl Alcohol."

THE FARADAY SOCIETY.

Report of the Council for the Year 1927, Presented at the Annual General Meeting, May 16, 1928.

Meetings.

Seven meetings were held during the year of which three were General Discussions, as follows :—

(i) March 30,

Dr. W. H. J. Vernon's second report on Atmospheric Corrosion to the Research Committee of the British Non-Ferrous Metals Research Association was presented before the Society and was followed by a full discussion. The report and discussion were published in No. 74 of the *Transactions*.

(ii) April 23.

"The Theory of Strong Electrolytes."

This discussion was held in the Department of Biochemistry, University Museum, Oxford. The President, of the Society Professor C. H. Desch, was in the chair. The subject was considered under two main headings :—

Part I. "Mobilities of Ions." (Introduced by Dr. E. Hückel on behalf of Professor P. Debye.)

Part II. "Activity." (Introduced by Professor J. N. Brönsted.)

Twenty-three papers in all, were contributed and a valuable discussion ensued. The report of the proceedings appeared in No. 77 of the *Transactions*. Among the distinguished foreign men of science present were Professors Brönsted, Bjerrum, Fajans, Harned, Hevesy, Remy, and Scratchard, and Doctors Christiansen, Hückel, Onsager, and Ulich.

The arrangements were made by a committee consisting of Dr. N. V. Sidgwick, Professor A. W. Porter, Sir Harold Hartley, Mr. H. . Raikes, Professor A. J. Allmand, and the Secretary and Editor.

(iii) November 28,

"Cohesion and Related Problems."

This discussion was held in the rooms of the Chemical Society. The President especially welcomed Professor Polanyi and Dr. Sachs of the Kaiser Wilhelm Institute, Berlin, and Professor Errera of Brussels.

The introductory survey was given by the President who also contributed a summary. Fifteen papers in all were contributed and a valuable discussion ensued. The report appeared in Nos. 81 and 82 of the *Transactions* and was published as a separate reprint.

The arrangements were made by a committee consisting of the President with Professor A. W. Porter, Professor E. N. da C. Andrade, Dr. H. Moore, Dr. H. J. Gough, and the Secretary and Editor.

Ordinary Meetings.

In addition to the three General Discussions, ordinary meetings were held on January 26, April 22, September 28, and December 14. Forty-three papers were presented at the ordinary meetings and thirty-nine at the General Discussions; eighty-two in all.

The Society is once again indebted to the President and Council of the Chemical Society for the use of that Society's rooms in Burlington House.

SEVENTH INTERNATIONAL CONGRESS OF PHOTOGRAPHY, LONDON, 1928.

The Seventh International Congress of Photography will be held in London on July 9—14, under the auspices of the Royal Photographic Society.

The Congress is being organised in co-operation with the Permanent Committee of Photographic Congresses, by a Committee of representatives appointed by the leading Scientific and Photographic Societies of Great Britain at the invitation of the Royal Photographic Society.

There will be three sections :—

1. Scientific and Technical, dealing with the Theoretical Aspects of Photography, Photographic Practice, Scientific and Industrial Applications of Photography.
2. Pictorial Photography.
3. Bibliography, Record Work and History of Photography.

Papers to be presented at the Congress, accompanied by abstracts, both in duplicate and typewritten, must be in the hands of the Secretary to the Congress before 1 June, 1928.

Exhibitions.

An important feature of the forthcoming International Congress of Photography is to be the holding of a series of Exhibitions in

connection with each of the sections of the Congress. These will be international in character, and will be open free to everybody and not confined to members of the Congress. The exhibition of pictorial photography will consist of a number of prints by British and foreign workers specially invited by the Pictorial Committee of the Congress. In the other sections a certain number of exhibits will be invited, but the Hon. Secretary will be pleased to hear from anybody who would desire to exhibit matter showing recent advances in photographic practice, scientific-photographic apparatus, illustrations of recent advances in the knowledge of the theoretical aspects of photography, new photographic apparatus, and so on. There will be a special section devoted to trade exhibits in all branches of photography and its applications.

The Royal Photographic Society's house at 35, Russell Square will be used for the Pictorial Exhibition only. The others will be held at the Imperial College of Science and Technology, South Kensington, S.W.7., which is the meeting place for the Congress.

Inquiries may be addressed to the Hon. Secretary of the Congress, Walter Clark, Esq., Ph.D., F.I.C., F.R.P.S., the Science Museum, South Kensington, S.W.7.

The Offices of the Congress are at 35, Russell Square, London, W.C.1.

NOTICES OF BOOKS.

A Text-Book of Organic Chemistry. Edited by J. Newton Friend, D.Sc., Ph.D., F.I.C. (Carnegie Gold Medalist). Volume X. — *The Metal-Amines.* By Miss M. M. J. Sutherland, D.Sc., F.I.C. Pp. 260. Price 18s. net. London: Charles Griffin & Co., Ltd., 42, Drury Lane, W.C.2.

In the series of works of which the present forms Volume X the periodic classification method has been adopted, and as pointed out in the preface the plan of dealing with one branch of chemistry has several advantages. The work is well written and there are pages in tabular form, the dates of the numerous chemical works and journals containing references to the subject dealt with by the author.

A Comprehensive Survey of Starch Chemistry. Vol. I. Compiled and edited by Robert P. Walton, in collaboration with some score of well-known writers. Pp. 360. Price $10. New York: The Chemical Catalog Company, Inc., 419, Fourth Avenue, at 29th Street, New York, U.S.A.

This important symposium which has New York Public Library, is a presentation of the various phases of Starch Chemistry and Technology. That the work is authentic can safely be assumed from the standing of the various writers who assisted in its compilation. While different phases of starch have been written upon by various writers, We do not recall a work that could compare in the extent and variety of its contents with the present book. One of the most abundant and useful commodities, starch occupies a deservedly prominent place in commerce and hence too much about its nature cannot be known. This, together with the importance of the present symposium, will ensure it a warm welcome from all those interested in the subject. It is no fault of the work that a considerable portion is occupied by references to both authors and works, so that the reader has available the combined experience of a large array of writers on the subject.

Three Italian Works.

(1) *Le Grandi Industrie Chimiche.* By Dr. Ant. Aita and Eng. H. Molinari. Pp. xvi + 472. Price 48 lire.

(2) *Dizionario di Sinonimi e Composti Chimici.* By Prof. C. Craveri. Pp. vi + 316. Price 35 lire.

(3) *L'Industria Chimico-Metallurgica.* By E. Crivelli. Pp. viii + 322. Price 35 lire. All published by Ulrico Hoepeli, Milan. 1928.

The first volume is dedicated to the late Prof. Ettore Molinari and deals with the three common mineral acids. It brings the earlier work of the celebrated Italian technologist more up to date as regards recent practice and statistics.

Prof. Craveri's Dictionary of Terms will serve chiefly for Italian chemists, industrialists and pharmacists. English readers acquainted with Italian will also find it useful for reference to technical terms.

The third volume is concerned with the uses of Copper Sulphate including its application as a fungicide. The author has taken much trouble to incorporate early historical matter so that his compilation has a general interest as well as a particular appeal to those making or using blue vitriol.

Die Massanalyse. Von Prof. J. M. Kolthoff. Zweiter Teil. Pp. x + 512. Berlin: Julius Springer. 1928. Price 20 m. 40 pf.

Part I of this work has already been referred to in *The Chemical News.* The present Part, prepared with the assistance of Dr. H. Menzel has been awaited with

of the recent and better known methods of volumetric analysis but a number of new processes which have appeared in this Journal have not received mention.

The first number of *The Instrument World*, a 6d. monthly Journal devoted to matters pertaining to scientific instruments, has just appeared. It contains several interesting and informative articles by experts. Among these mention may be made of the first instalment of a Dictionary of Technology and Trade Terms. If the promise of the first number is maintained, the Journal should serve a useful purpose.

FORTHCOMING EVENTS.

ROYAL INSTITUTION OF GREAT BRITAIN.

Albemarle Street, London, W.1.

Friday, May 25.—A. C. Egerton, M.A., F.R.S., M.R.I., Reader in Thermodynamics, University of Oxford : " Engine Knock and Related Problems."

THE INSTITUTION OF MINING AND METALLURGY.

Special Meeting of the Institution in Cornwall, May 22, 23, and 24, 1928.

The Council have accepted a cordial invitation from The Cornish Institute of Engineers, The Cornwall Chamber of Mines, The Royal Cornwall Geological Society, The Royal Cornwall Polytechnic Society, and The Royal Institution of Cornwall, to hold a Meeting of the Institution in Cornwall.

The Meeting will be held on Tuesday, Wednesday, and Thursday, May 22, 23 and 24 (the week preceding Whitsuntide).

UNIVERSITY COLLEGE.

Gower Street, London, W.C.1.

Tuesday, May 22, at 5 p.m.—The Burge Memorial Lecture : " International Arbitration," by the Rt. Hon. the Viscount Cecil of Chelwood.

Chairman : The Master of Balliol College, Oxford. (This Lecture is arranged by the Burge Memorial Trustees.)

Thursday, May 24, at 2.30 p.m.—" Recent Discoveries." A public lecture by Sir Flinders Petrie, F.R.S., F.B.A., Edwards Professor of Egyptology. (Repeated on Friday, May 25, at 5.30 p.m., and on Saturday, May 26, at 3 p.m.

Thursday, May 24, at 5.30 p.m. — " Abraham Lincoln." A public lecture by Major George Haven Putnam.

Thursday, May 24, at 5.30 p.m. — " Alessandro Manzoni." A public lecture in Italian by Dr. A. M. Bassani.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

12,400— Holzverkohlungs-Industrie Akt.-Ges.—Concentrating volatile aliphatic acids. April 27th.

12,162.—I. G. Farbenindustrie Akt.-Ges. Manufacture of derivatives of glycols. April 25th.

11,896.—Newport Co.—Bromination products of 4, 4'-dimethyl-6, 6'-dichloro-thio-indigo. April 23rd.

11,871.—Reynard, O.—Obtaining alginic acid, etc., from seaweed. April 23rd.

12,380.—Verein fur Chemische und Metallurgische Produktion. — Manufacture of sulphuric anhydride, etc. April 27th.

Specifications Published.

289,105.—Smith, S. C.—Manufacture of salts of lead.

289,128.—Stettiner Chamotte-fabrik Akt.-Ges. vorm. Didier. — Ovens for chemical-metallurgical and like processes.

289,154.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of indigoid dyestuffs.

289,241.—I. G. Farbenindustrie Akt-Ges. Manufacture of sulphur dyestuffs.

287,076.—Flesch, H.—Production of sulphuric esters of poly-oxyfatty acids.

Abstract Published.

286,865.—Sulphuric acid. — Soc. General Metallurgique de Hoboken; Hoboken-lez-Anvers, Belgium.

In manufacturing sulphuric acid in packed chambers or towers as described in Specification 249,914, a substance having a high

packing-material, in order to counteract fluctuations in the temperature of the gases, external temperature, etc. The temperature inside the chamber may be maintained almost constant by varying the temperature or the amount of the acid which is circulated through it. The chamber is formed of snch shape that its surface is the minimum for the volume, for example, in the shape of a cube or of a cylinder the diameter of which is equal to the height.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

EVEREADY PRESTONE.

486,497.—Chemical substanees, in class 1, for the prevention of freezing and boiling of water in radiators in connection with internal combustion engines.—Carbide & Carbon Chemicals Corporation, 30, East Forty-Second Street, New York, State of New York, United States of America. May 2nd.

PRESIDENT.

489,606.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—Co-operative Wholesale Society, Ltd., 1, Balloon Street, Manchester. May 2nd.

YESTAMIN.

487,898.Chemical substances prepared for use in medicine and pharmacy.—The English Grains Company, Ltd., 30, Union Street, Burton-on-Trent. May 2nd.

VALIXIR.

489,128.— All goods in class 3 which includes chemical substances prepared for use in medicine and pharmacy.—Cooper, Son & Co., Limited, 80, Gloucester Road, South Kensing-

JUST PUBLISHED.

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CONTENTS. PAGE.

Science Training	321
By Robert Saxon, B.Sc., F.C.S.	
Alloy Steels — Their Manufacture, Properties and Uses	324
By H. C. H. Carpenter, M.A., F.R.S.	
Scientific Research as Applied to Industry.—Address by Sir Alfred Mond	326
Progress in the Metal Industries	328
The Clean Air Campaign	328
Fuel Industries and the Work of the Chemical Engineer	329
General Notes :—	
Chemical Products in Canada	330
Statistical Abstract	321
Proceedings & Notices of Societies :—	
The Chemical Society	332
The Physical Society	332
The Geological Society	333
The Institute of Chemistry Pass List	334
Forthcoming Events	335
New Patents	335
New Trade Marks	336

UNIVERSITY OF LONDON.

A Course of Three Lectures on

"CHEMICAL KINETICS"

will be given by

PROFESSOR MAX BODENSTEIN

(Professor of Physical Chemistry in the University of Berlin) at UNIVERSITY COLLEGE, LONDON (Gower Street, W.C.1.) on MAY 31ST, JUNE 1ST and 4TH, at 5.30 p.m. At the first Lecture the Chair will be given by Professor F. G. Donnan, C.B.E., F.R.S. (Professor of General Chemistry in the University).

Admission Free, Without Ticket.

EDWIN DELLER, *Academic Registrar.*

SCIENCE TRAINING.

By ROBERT SAXON, B.Sc., F.C.S.,

Member of American Chemical Society.

It would be well for the future of science training in this country if people responsible for it were considered as a limb of the associations which work for its advancement. Methods of developing scientific methods of work and reasoning in the young are of the highest importance to the growth of science. Unscientific approaches to the study of nature's secrets are criminal frauds, likely to produce quackery instead of truth, and yet science is looked upon as a spectacular entertainment instead of an untiring life-long devotion to the theory that it is bad enough to even unwittingly give a wrong or ill-matured conception to another but it is weakness to deceive one's self for without such deceit the passing of it on would be impossible. To impress the student that it is the truth that he is after, and that the chase is worth while no matter how long it last, is of the highest importance, and for that reason worth the attention of every society devoted to scientific research. For that reason science trainers all over this or any other country ought to be admitted as a section of one of these societies. As a branch they could have a portion of the journal allotted to them, thus helping the same for discussing means of teaching, training, research, and mutual suggestion with regard to unexplored fields.

At the seventy-fifth meeting of the American Chemical Society, St. Louis, Mo., from April 16 to the 19, on the organisation plan out of seventeen items we have the following: "Chemical Education, Executive Committee; Senate and Division of Chemical Education; Chemical Education; Editors, Journal of Chemical Education; Chemical Education; five items out of the whole seventeen. The Educational section threw its doors open to the public for four addresses—President S. W. Parr: "Some Combustion Problems in their Relation to Public Health"; Dr. Wm. J. Mayo, Rochester, Minn.: "The Advancement of Learning in Medicine through Biochemistry"; Motion Picture Films Showing Growth of Crystals, from Eastman Kodak Co.; Charles Allen Thomas and Carrol A. Hochwalt: "Effect of Alkali Metal Compounds on Combustion." The Division of Chemical Education staged 23 addresses, one by the President of The American Chemical Society and another by the Editor and Business Manager of the *Journal of Chemical Education*. Among these were the

following :— " The Prediction of the Future Performance of Students from their Past Records " " The Deadly Parallelism between High School and First Year College Chemistry," " The Periodic Law as a Practical Means of Correlating the Facts of Chemistry," " The Technic of Conducting the Introductory College Course in Quantitative Analysis,' " A General Definition of Acids, Bases and Salts," " A Laboratory Experiment Illustrating Voltaic Polarisation," " Evening Instruction for Chemists in Industry—The Chicago Plan," " A Comparison by Colleges of Examination Grades in General Chemistry." These were in some cases illustrated by lantern and one address was " *Increasing the Usefulness of the Projection Lantern.*" It could easily be possible for one of our scientific societies to do similar work in this country and empire of ours. Very few teachers of science here know how ready manufacturers are to supply illustrations and specimens of their products to schools and colleges. These are of paramount value. The fabrication of optical, physical, chemical, and engineering parts is interesting and encouraging to research, for it shows how great difficulties are encountered and overcome. This commonsense sympathy between industry and education could be used to great advantage if some society interested therein would open its doors to those whose mission is to equip the future generation with workers and philosophers. The American Chemical Society gives lectures to teachers, and American Universities throw open their laboratories in the evenings and vacations to the public. They scatter their seed like nature with a prodigal hand, for they knew full well that no man may say which soil will be the most fruitful. Nature's book of learning is nature herself. We have too many readers and too few workers.

It should be remembered that science cannot easily be practised outside a laboratory, any more than a foreign language may be acquired away from the teacher and his pronunciation. For that reason laboratories should be available to laymen desirous of working in them during recesses, and central laboratories to teachers to meet, work, and absorb sufficient interest to enable them to carry on the good work in their own spheres of influence. They should keep awake that native curiosity with which every child born of sane parents is furnished. That natural inquisitiveness and love of expression either verbal or manual if starved will inevitably die, and result in a nation of seekers after formulæ and recipes instead of cultivators of the truth. One sees too often cases where the constructive power in the imagination is dead in early manhood and the joy of declaring one's conceptions in prose, music, with pen, pencil, or brush, has departed in early youth. How many boys of fourteen have any delight in expressing themselves in clear diction? Not many. Yet the children in junior departments bubble over in their desire to talk, write, draw, recite and sing.

The balance, a most capable assistant, may be constructed with a wooden beam. A metre scale makes a good one. Holes are made at intervals of ten centimeters to accommodate glass rod or tube as central knife edge. This resting on glass will give a sensitiveness of one mg. Pans may be made of aluminium and need not be hollowed. By attaching square pans by four strings in the same manner as that by which the ballistic pendulum is hung twisting is eliminated and resistance to the forceps afforded even when the beam is swinging. A cam for raising the beam may be made by drilling a disc eccentrically and running a rod through this " excentre." Now such a cam operates in the automatic weighing machine " NO SPRINGS," the cam in turning and unwinding a chain under the influence of weight, offering a varying leverage to balance a weighted lever. This can easily be shown by drawing. The cam turning the needle indicates the weight. Reference to other uses of principles we come across will make the student take a double interest in his research, and make the world around him one inexhaustible mine of philosophy. Having built up the balance we may teach the principles of equations. Take a number of bearing steel balls of equal size and counterpoise them with weights, using concave pans. The weight of one ball being taken as x, we have the equation illustrated

$$ax = w$$

where a is the number taken, and w the total weight. Weigh one to confirm. Always confirm. Now place a definite weight, say 200 grams, in each pan and adjust a monkey rider to assure balance. Place a number of balls on one pan and remove weights until balance is again obtained. Then we have

$$bx + c = 200$$

where b is the number of balls, and c the weight that it left. Now if c be taken from both sides of the balance we shall again get equality, and may write

$$bx = 200 - c.$$

and the student sees what we mean by " swinging across and altering signs. He

is introduced to something else of great importance. No balance is without faults, as anyone may appreciate if he weigh on alternate pans. He has to learn correction of experimental errors. Now, although his balance may be a very poor one, it is obvious that as the balls replaced the weights taken off, one must be exactly equal to the other. And this is the principle of *replacement weighing* or *Borda weighing*, for we might make a counterpoise to the 200 grams and fix it to one end of the beam. Then we begin with 200 grams in the pan counterpoising, and take weights off equal to the object we are weighing. Thus we have a one-arm balance which gives the true weight, provided our set is accurate.

Now take balls of two sizes and place a mixture on the pan and ascertain the weight. Do this again with a different mixture. Thus we get—

$$ax + by = w, \text{ and}$$
$$cx + dy = z$$

where a, b, c, d, represent the numbers of balls taken of each size, and w and z the respective total weights. Multiplying throughout the first equation by c and the second by a we get two equations enabling us to eliminate x, and this can be confirmed by taking the actual numbers of balls and counterpoising. Similarly for y, using as factors b and d. By weighing with *constant load*, say 200 grams (that is Borda weighing), we have

$$ax + by + f = 200, \text{ and}$$
$$cx + dy + g = 200$$

where f and g are the weights taken off to establish balance or equilibrium. The student sees that—

$$ax + by + f = cx + dy + g$$

and experiment accordingly to get x in terms of y.

The laws of *Ratio* and *Proportion* can be made real by this balance. Take out the support rod or tube and replace in one of the holes not in the centre. Remove the pans, weigh them and replace. We may understand in a rough way the action of weighing machines, and how a small weight may balance a greater one. By experimenting with various weights, adding the weights of pans every time, we may play with the equation—

$$ab = cd$$

where a and c are the weights counterpoising each other, and b and d the respective distances of fulcrum from pan attachment. We may see that—

$$a : c = b : d.$$

If now we attempt to obtain the weight of an object, say a 50 gram weight, by one pan and then the other we have the equation again—

$$50h = cd$$

the 50 replacing the a. Also—

$$ab = 50d$$

in the second weighing. Obviously

$$50b : ab = cd : 50d$$

and $$50 : a = c : 50.$$

From this we see that—

$$50^2 = ac.$$

Thus we learn the law of correction for a very faulty balance, namely, that we weigh in both pans, multiply the weights together and extract the square root to get the real weight.

The use of a rider may be shown on the beam of our balance, and the weight of a rider may be got at by placing in two different positions on the beam, and counterpoising, with of course the fulcrum at the centre. Where we are concerned with the weight of the beam we may obviate error by placing two beams together, and sliding one along the other until equilibrium is obtained without the pans, or sliding a weight along a single beam for the same purpose.

The working of a balance with constant load may be obtained by weighting the beam at one end and providing a double pan at the other. On the lower shelf of this pan we place the weight that will counterpoise the weight on the end of the beam. This is arranged to be 200 grams generally. The object to be weighed is placed on the upper shelf, and weights are taken off to obtain equilibrium. These obviously are the same as the weight of the body, for it has taken their place. Thus we see a few of the uses of a balance. It is not at all according to the rules of scientific thought to allow a student to go straight to a laboratory balance without preliminary training to see the chances of error and methods of correcting such. Other aspects of this will be treated later.

NEW PLANT RESEARCH LABORATORY OF ALBERTA UNIVERSITY.

A new plant research laboratory is to be erected on the University of Alberta $50,000, according to Dr. H. M. Tory, President of the University Three research experts to be provided by the Federal Department of Agriculture will be permanently assigned to the laboratory, with an equal number of local men. Dr. Sanford, who will be in charge of the work is expected to arrive from Ottawa shortly.

Special attention is to be given to the study of root rot and research work along

ALLOY STEELS — THEIR MANUFACTURE, PROPERTIES, AND USES.

By H. C. H. Carpenter, M.A., A.R.S.M., F.R.S.

Professor of Metallurgy, Imperial College of Science and Technology.

Tungsten Steels. Chromium Steels. Manganese Steels.

(Second Cantor Lecture delivered November 21, before the Royal Society of Arts.)

(*Continued from Page* 310

Properties and Uses.

The oldest use of chromium steels which is still current, is for stamp shoes and dies for crushing gold and silver ores. These contain from 0.8 per cent. to 0.9 per cent. of carbon, with 0.4 per cent. to 0.4 per cent. of chromium. Toughness as well as hardness are essential properties of these steels, and some annealing is always employed in their heat treatment. This increases their durability to a marked extent. Another important use is in the form of 5-ply plates for the manufacture of safes.

As previously mentioned, Mr. Brearley's discovery of the corrosion-resisting properties of chromium steels was unpremeditated. He was engaged at the time in a research on the resistance to erosion of various steels for ordnance purposes. Among the steels examined were some containing large amounts of chromium in different conditions of heat treatment. It was noticed that the high chromium steels were either not etched at all or could only he slightly etched by the usual agents employed in the microscopic examination of steel sections, and further, that they did not rust in the atmosphere of the physical labortory. Under certain conditions produced by heat treatment, however, these steels could be etched and did not exhibit anti-rusting properties to any thing like the same degree.

The discovery of Mr. Brearley's has proved very fruitful and has led to the manufacture of steels of a new type, viz., the stainless steels. Not all of these are plain chromium steels—some of them contain nickel as well —but all of them without exception contain chromium in considerable amounts, and the essential corrosion-resisting properties are due to this metal.

Stainless steel was introduced to the public in 1914 in the form of table cutlery and as Mr. Monypenny points out "The fact that it was almost exclusively used for cutlery purposes for a considerable period of time after that date, has led to the belief, probably widely held, that stainless steel is simply a special type of cutlery steel with a very limited range of mechanical properties. It has even been considered to be a special form of plating. If this were so, stainless material would have a very limited application and would not be of great interest to engineers. Fortunately, however, this is not the case. Stainless steel is really a whole series of steels whose mechanical and physical properties vary widely in a similar manner to the variations met with in the different varieties or tempers of ordinary carbon steels, but which all have the distinguishing property of great resistance to corrosion conferred on them primarily by the presence of a considerable percentage of chromium. As a general rule the amount of this element present in stainless materials is in the range of from 7 per cent. to 14 per cent."

Recent progress in the manufacture of corrosion-resisting alloys has depended on the use of nickel in addition to chromium. The alloy manufactured in England under the name of "Staybrite" contains 18 per cent. of chromium and from 8 per cent. to 9 per cent. of nickel. The German alloy known as V2A contains from 20 per cent. to 25 per cent. of chromium and 6 per cent. of nickel. Unlike ordinary stainless steel, which is a two-phase alloy in the unhardened state, these alloys consist of a single phase. The iron is in the gamma (austenite) condition. These alloys are ductile and can be worked into almost any form. "Staybrite" can also be welded. Unlike, however, the stainless steels containing only chromium as an alloying element, it cannot be hardened by quenching, although a certain amount of work-hardening can be obtained. These alloys resist various acids which appreciably attack ordinary stainless steels, notably phosphoric, acetic, formic, tartaric and citric acids. When completely immersed in sea-water at the ordinary temperature "Staybrite" appears incorrodible. Partial immersion, however, especially in aerated sea-water, may cause a breakdown at the water level and the attack spreads from that point along the entire water line.

Manganese Steels.

The metal manganese occupies a position of peculiar importance in steel metallurgy. It is required in the manufacture of all ordinary steels and in spite of a large amount of investigation no satisfactory substitute has yet been found for it. Very large quantities are therefore annually used for this purpose. It is also a constituent for

one of the most important alloys ever made —the so-called "Manganese Steel." This alloy in the commercial meaning of the name, is a variety of steel containing from 1.0 per cent. to 1.3 per cent. of carbon and from 11 per cent. to 14 per cent. of manganese. The original patents covered steels with from 7 per cent. to 30 per cent. of this metal, but alloys within the limits of the composition given have the greatest strength and ductility and are, therefore, generally used. The discovery of this steel and the working out of its properties over a period of many years will always be associated with the name of Sir Robert Hadfield. It is undoubtedly one of the most important alloy steels ever discovered and certainly it has become the most famous of any. It was the pioneer of steels of a new type and the economies resulting from its use in various fields of service have been remarkable. As Mr. Hibbard has pointed out: "Perhaps the most conspicuous example of its use was in connection with the Panama Canal where years of time and millions of expense were saved by its use." The bulk of the manganese steel made at the present time is employed in the form of castings, but the use of hot-worked ((rolled and/or forged) manganese steel is now also of considerable importance.

The Influence of Manganese on the Melting Points and Inversions of Carbon Steels.

Manganese is by far the most fusible of the metals used in Alloy Steel Metallurgy. Its melting point is about 1260° C. Its addition to iron lowers the melting point fairly uniformly from 1535° C., and the melting ranges of all alloys lie on a smooth curve between these two points. Manganese steel of the above composition melts at about 1325° C., whereas a pure carbon steel of the same carbon percentage melts at about 100° higher. This increase in fusibility is commercially advantageous because it lowers the cost of founding the steel.

Manufacture.

Manganese steel is still made in the ladle, according to Hadfield's expired patents, by mixing decarburised iron containing not more than 0.1 per cent. of carbon with 80 per cent. ferro-manganese. The iron is melted either in a pneumatic converter or an open-hearth furnace. The ferro-manganese has also to be melted or at any rate heated nearly to the melting point, since it forms such a large proportion of the charge, *viz.*, about one-seventh. This process is usually effected in graphite crucibles heated in coal-fired holes. The life of these pots is from 8 to 10 heats. Allowance has to be made for loss of manganese by oxidation. If a finished steel is required to contain 12.5 per cent., then about 14 per cent. of manganese must be used in the charge. Efforts have been made to melt the ferro-manganese in a cupola because of the high cost of melting in pots. In this case, however, there is always more loss of manganese which offsets to some extent the lower cost of melting. The loss can be diminished by charging the ferro-manganese in the centre of the cupola and surrounding it by coke so that the metal is largely protected from the free oxygen of the blast.

Composition and Properties.

Analyses of manganese steel lie between the following limits :—carbon from 1.1 per cent. to 1.8 per cent.; manganese 11.0 per cent., to 14.0 per cent.; silicon 0.3 per cent. to 0fl8 per cent.; phosphorus 0.05 per cent., to 0.08 per cent. The sulphur content is so low as to be negligible. Steels containing from 7-8 per cent. of manganese, however, are finding some use. They have a higher and better defined elastic limit that the steel whose analysis has just been quoted. Their ductility, however, is very much less, but they are cheaper to make, and they do not flow under impact so freely as the ordinary commercial grades. Their structure is martensitic and not austenitic.

Manganese steel may be regarded as a hard self-hardening steel owing this property to its composition. It cannot be softened by heating followed by slow cooling but requires an accelerated rate of cooling. It has a high coefficient of expansion and small paterns are made with a shrinkage of five-sixteenths of an inch to one foot, which sometimes is not quite enough. Its specific gravity is about the same as that of a plain carbon steel of the same carbon content. For a metal it is a poor conductor of electricity. Perhaps its most remarkable property is its almost total lack of magnetic pereability and susceptibility. Although it contains 85 per cent. of iron in a metallic form, it is so slightly attracted by a magnet that no pull can be felt by the hand. As contrasted with this, magnetic oxide of iron containing about 70 per cent. of iron in a non-magnetic form is quite strongly attracted.

MERIT NUMBERS OF VARIOUS METALS.

Metal	Tensile strength lbs. per sq. in.	Elongation per cent.	Merit number.
Manganese Steel	140,000	50	7,000,000
Nickel Steel heat-treated	207,000	14	2,898,000
Nickel Steel untreated	95,000	21	1,995,000
Soft Steel	60,000	30	1,800,000
Tool Steel	130,000	5	650,000
Cast Iron	20,000	0.5	10,000

SCIENTIFIC RESEARCH AS APPLIED TO INDUSTRY.

STRIKING ADDRESS BY SIR ALFRED MOND.

Sir Alfred Mond addressed The Chemical Industry Conference, held under the auspices of the Society of Chemical Industry and the British Science Guild, at the Institution of Civil Engineers on Tuesday, May 15, on "Scientific Research as Applied to Industry." Sir Ernest Rutherford, President of the Royal Society, occupied the chair.

Sir Alfred said that the Conference had been called as a friendly reply to Lord Balfour who, in his address when he received the Messel Memorial Medal, said that whilst Great Britain had always excelled in pure science, she had never applied science to industry satisfactorily, but had allowed brilliant ideas originally evolved in this country to slip abroad and to return here as fully fledged industrial processes, on account of our lack of ability to put such ideas into practice.

Sir Alfred said he would take up Lord Balfour on both points. In the first place, pure science was the monopoly of no country and it was always possible to place one's fingers on shining examples in this respect in all civilised countries. On the other hand he denied that Britain was in any respect behind in the application of science to industry. He specially instanced the question of Dyes. The public seemed to have an obsession that because Perkin discovered the original mauve dye and the dye industry later became flourishing in Germany, that the chemical supremacy of this country was thereby endangered. He denied any overwhelming importance of the dyestuffs industry. Dyes were not the beginning and end of the chemical industry. One of the principal reasons for the slow development of the dyestuff industry in this country was due to the great legal skill shown by our competitors with respect to patents. They had succeeded in the past in tying up the dyestuffs industry of this country to an extent which has never been fully realised.

The beginning of the industrial era was definitely and completely a British movement and standing in the Institution of Civil Engineers, he had only to recall the names of Watt and Stephenson to emphasise the point that the industrial revolution was born in Britain. While the industrial revolution was commenced by inventions in engineering it was followed by discoveries of the first rate importance in metallurgy, which he claimed was a branch of chemistry. In metallurgy he only had to mention the names of Bessemer, Siemens, Gilchrist, and Lothian Bell, to prove that in the sphere of metallurgy, Britain had been the pioneer. Similarly in electricity and modern engineering, Britain had led the world. He had only to mention the name of Sir Charles Parsons to establish this point.

This Conference had been called, however, to consider Research as applied to the Chemical Industry. British achievement in the chemical and allied industries had, over the last one hundred years, been outstanding. Among the splendid band of leaders had been Henry Muspratt, Alfred Nobel and Ludwig Mond. More recently, two Englishmen, Cross and Bevan, had established the artificial silk industry, now rapidly becoming one of the leading industries of this country.

After all, the heavy chemical industry was the backbone of all chemical industries, humble though their products might appear. Among the chief of his father's attainments, had been the development of the Ammonia Soda process, the discovery of the Mond Nickel proces — a process unique in its chemical character — and the Mond Gas process which might be classified among the first attempts to find a solution to the low temperature carbonisation question. Sir Alfred then mentioned his father's early foresight on the Nitrogen problem. The Mond Gas process produced at that time the highest yield of nitrogen-hydrogen from coal in the form of ammonia, and had it not been for later and more direct developments in this direction this process would have un-

doubtedly have occupied a large place in the production of fertilisers.

British Scientific achievement could claim full credit for its achievements during the war. There was a general shortage of all war materials. With the aid of British chemists, T.N.T. manufacture developed from pounds to tons. Ammonium nitrate, however, was the principal war material produced by the British Chemical industry. The processes as used in this connection were based upon the theoretical work of an American scientist, Willard Gibbs, who laid down general laws governing the reactions of chemical substances. In his own organisation the distinguished scientist, Major F. A. Freeth, a Fellow of the Royal Society, who he was glad to say was still with them, applied Gibbs' phase rule to one of the most vital national requirements of the time. This achievement had a material effect on the Allies' success.

There had been a tremendous expansion in the British Chemical Industry since the war. This was the direct result of the first signs of the exhaustion of the more easily accessible fertile areas of the world. In this expansion a tremendously important part had been played by engineering. Britain had always been the pioneering country of the world and the lead was still maintained. He instanced Colonel G. P. Pollitt'e achievement in the application of high pressure technique to the fertiliser industry at Billingham.

Modern research required new methods of attack. One of the greatest disadvantages from which the chemical industry had suffered in the past was the fact that the laboratory and the works man had as it were existed in mutually hostile compartments. The one alleged that the practical man knew nothing, the other that the laboratory man might be all right but he was no good when he came to practice. They had now got beyond this.

It must not be forgotten that discoveries could not be made to order. It was no use summoning a hundred men and asking them to make discoveries as one ordered a hundred new suits from tailors. No one would dream of telling a man that he must write an opera or paint a picture. They had to wait until the man capable of doing it came along. Genuine discoverers were born, not made, and were frequently individuals not in any way connected with industries.

In the past there had not been sufficient liaison between the academic and the practical sides. In Imperial Chemical Industries, Limited he had met this by forming a Research Council, of which he himself was Chairman. He was glad to say he had obtained the services of some of the most distinguished men in the country to work on it. There was no question of these gentlemen being asked to make immediate contributions to the practical problems. Their duty was to look ahead. Imperial Chemical Industries were also considering a scheme whereby some of their chemical staff could work in the atmosphere of the University. From this he felt mutually beneficial results to both the academic and industrial worker would accrue.

One of the most serious indictments which might have been levelled against British industry in the past was the timidity of the capitalist. While there was a complete answer to Lord Balfour's charge on the application of science to industry in Britain, he would have been on surer ground if he had criticised the lack of the application of science to industrial organisation in this country. That intense national individuality which had promoted invention in Britain had militated against industrial organisation. He was optimistic about the complete picture of Britain's industrial future. It was true that there were industries which were in backwaters and that there were industries which were bankrupt. Those industries which had applied the principle of the science of organisation were prosperous and progressive. Those which had failed to utilise the opportunities which this science offered were depressed and retrogressive.

The great advantages of amalgamation were the way it enabled the talents of every industry to be collected in a common pool.

He had just returned from a ten-day Conference on a ship in the Adriatic where the Nitrogen experts of the world had been in Conference. They had been considering the problem of feeding the teeming multitudes of the world. He would say that the most important thing to mankind at the moment was cheap Nitrogen. It was true, Nitrogen was not the only fertiliser required, but the British chemical industry was in a position to offer complete fertilisers for all purposes in which the three essentials of nitrogen, potash and phosphates could be mingled in an almost infinite variety of ways.

Turning to the future, no one could say what it held in store. Bio-chemistry, for example, was a science which was just beginning to come into its own and held great possibilities for the future. He claimed that the achievement of the British Chemical Industry was equal to that of any other country and its national importance could

not be exaggerated. National progress, national health and national economy were dependent upon it. The past and the present justified themselves. Looking into the terra incognita still to be explored by the younger generation he had every faith that they would maintain the supremacy already established.

PROGRESS IN THE METAL INDUSTRIES.

A number of striking features in the progress of industrial research are brought out in the 8th Annual Report of the British Non-Ferrous Metals Research Association which was presented to its members at the Annual Meeting and Luncheon held in Birmingham on May 14.

The main work of this Association is the carrying out of scientific and technical investigations on metals and alloys to provide new knowledge for assisting in the advance of industry. The growth of this work has been remarkable as is indicated by the expenditure on these investigations, which in 1927 amounted to £20,000 as compared with £600 in 1920. Nearly 85 per cent. of the Association's income has been spent on such productive work, some 36 researches being in progress or already completed.

The subjects of investigation have been selected to cover the widest possible field in the metal industries, to satisfy the requirements of the members who comprise manufacturers and users. The researches include studies on Copper and Brass with the obect of improving the quality of commercial material; the exploration of improved alloys for high temperature service; the production of better electro-deposited coatings; Lead alloys for cable sheathing and pipes; Die-casting alloys; Sheet Zinc; Locomotive Firebox Stays; Condenser Tubes and Atmospheric Corrosion.

The results of the past few years' work have yielded results of great practical importance; several new materials and processes have been discovered and some of these have been protected by patents, which are being licensed to members.

Realising that its function is to foster the application of science by industry, the Association has just founded a "Development Section," whose object it is to assist industrial members to apply in their works the findings of scientific investigations which the Association has carried out. The success of this new enterprise has been astonishing, and it appears to be destined to play an important part in bridging the gap so often found between science and industry.

It would be difficult to over-stress the importance of the Association's work, not only to the metal manufacturers, but also to the engineering and other industries where non-ferrous metals are so largely used, and increasing numbers of "user" firms are joining the Association in order to be able to secure guidance in the selection of improved materials, the provision of which often forms the basis of new engineering advances.

Mr. Thos. Bolton, Chairman of the Association and Professor D. Hanson, spoke at the Annual Meeting and emphasised the need of further support which was warranted by the past successes of the Association. Mr. Gilbert C. Vyle urged that industrial firms should make provision in their accounts for research expenditure on a scale adequate to balance the items of depreciation in plant and machinery and of obsolescence of ideas and processes. Mr. H. T. Tizard, of the Government Department of Scientific and Industrial Research, pointed out that the increased State grant to the Association during the past year demanded a corresponding effort from the members and the industry.

The Annual Report is an admirable comment on the advanced modern outlook of one section of progressive British Industry and should be obtained from the Association's Headquarters, 71, Temple Row, Birmingham, and studied by all firms who make, use or sell non-ferrous metals in any form.

LONDON PRIVATE BUILDERS JOIN IN CLEAR AIR CAMPAIGN.

All-Gas Homes.

The lead given by many municipal authorities in the campaign to do away with domestic smoke by encouraging the use of smokeless cooking and heating appliances in new housing schemes, is being widely followed by private enterprise throughout the country.

In a number of new building schemes that are now being carried out in and around London, provision has been made either for the exclusive use of smokeless fuels or for the means whereby they can be brought readily into service as an alternative to coal. Thus, in an estate that is being developed in the Hampton district, just outside the Western boundary of the Metropolitan area, all the houses have been wired for electric lighting and "carcassed" for a gas supply in every room.

All-gas houses are also being erected in considerable numbers in Sutton, Surrey. In each of these a modern gas cooker is being installed together with a gas copper and a circulator for hot water. Gas fires are provided in the living-rooms and bedrooms. These dwellings, which cost less than £700 freehold, are designed on labour-saving lines and are intended for working-class occupation.

On the North side of the Thames, new smokeless villages are being created in the districts of Edgware, Harrow, Hendon and Wembley. A large area at Wembley Park is being laid out as an estate, each house being designed and equipped to make the fullest use of all available sunshine. These dwellings are of attractive appearance with serviceable interiors including a roomy lounge hall and a tiled scullery and bathroom. Lighting is provided by electricity, and heating and cooking by gas.

THE FUEL INDUSTRIES AND THE WORK OF THE CHEMICAL ENGINEER.

By SIR ARTHUR DUCKHAM, K.C.B.

(Abstract of paper given at the Chemical Industry Conference, Monday, May 14, at 10.30 a.m. Chairman: Sir Hugo Hirst, Bt.)

Chemical Engineering stands for efficiency in operation and development, and therefore its application to the fuel industries is of vital importance. I would describe the chemical engineer as a man, firstly having sufficient chemical knowledge to appreciate the trend and results of chemical research and the ability to use such knowledge, and secondly, having sufficient engineering training and practical experience to devise and operate plant with which to obtain the desired results.

To attain the desired standing of a chemical engineer, I would lay most emphatic stress on the necessity for practical experience. In process development and operation, practical experience is of far more vital importance than, in what might be termed, straight chemistry or engineering. Reactions that cannot be foreseen through book or laboratory knowledge, continually arise, stresses occur and changes in the physical property of materials become apparent which are not foreshadowed in engineering handbooks or taught in colleges.

In many phases of industry, the chemical engineer eventually must play a determining part. As my experience eventually increases, as I learn of and appreciate the new ideas and inventions that are evolved in ever increasing numbers, I become more and more convinced of the great scope there is for improvement, even in our latest methods, and of the splendid prizes still to be won by the application of technical knowledge, imagination and driving force to the daily problems of industry.

The basic need in industry is to get exact knowledge of what we are doing. Each process must be dissected, step by step; its yields, its losses and its costs in material and labour must be made clear. With such knowledge available, it becomes possible to make improvements, to apply new methods, and even to develop fundamental changes to supersede hitherto accepted practice.

In all phases of industry the experience of the chemical engineer is of importance when dealing with stores. The suitability and the economics of lubricants, the wear and tear of wire ropes, timber and other materials are points where his specialised knowledge will show improved returns.

When we come to examine in detail the fuel industries, it is found that the work of the chemical engineer is of great importance. The cleaning of coal by either dry or wet processes, the efficient carbonisation of coal, the preparation of oils from coal, the manufacture of pig iron, the manufacture of steel and the heating of kilns and furnaces are all propositions wherein the specialised knowledge of the chemical engineer is needed. In the carbonisation industries, for example, there are at the present day a number of problems requiring the work of chemical engineers. The preparation of satisfactory refractory materials with good jointing and patching cements to meet all reasonable temperature conditions, methods for rendering sulphate effluent innoxious, a method of liquid purification of gases from sulphur compounds, the manufacture of a dense, ash-free, easily-ignitable smokeless fuel, the preparation of a suitable cheap metal, presumably iron, which will stand up under working conditions of, say, 750° C. for a thousand days, are typical problems which require solution.

Or again, there is the problem of the preparation of oils from coal. Those of us who have followed the development of such processes as that invented by Bergius must realise the immense amount of work that has been done, but must also realise the immense amount of work that lies ahead in order to make the process truly economical. Numerous problems that arise are capable of solution only by close working between the laboratory and the works plant. Only

by practical experience can the difficulties be discovered; only by a sound knowledge of chemistry and engineering can they be overcome.

Let us appreciate the necessity for chemical engineers in the fuel industries. Let us *create the demand*; I am sure it will be met. We must treat these men well. High salaries properly earned are a sound investment. In any of the operations I have mentioned, a good man can earn a good salary many times over.

CHEMICAL INDUSTRIAL CONFERENCE DINNER.

Progress of Chemical Industry.

The Chemical Industry Conference dinner was held on the evening of May 14, at the Connaught Rooms, Mr. Francis H. Carr, the president of the Society of Chemical Industry, was in the chair. It was announced by the chairman that Sir Philip Cunliffe-Lister, the President of the Board of Trade, who was to have been present, had so far recovered from the slight operation he had undergone that he hoped to resume his departmental duties on Monday.

Mr. H. G. Williams, Parliamentary Secretary to the Board of Trade, proposing the toast of "The British Chemical Industry," said that in pre-War days when one thought of chemistry one thought of Germany, but to-day he thought of this country. (Cheers.) Speaking of the Dyestuffs Act, Mr. Williams said that that measure, although revolutionary, was justified by results. In pre-War days we imported 80 per cent. of our dyestuffs; to-day we imported only 20 per cent. While the industry had made great progress there were further fields to conquer. He had to report with profound regret that in the last 18 months the Board of Trade under powers conferred on it had had to remit duties on 45 separate chemical products, for the reason that those chemicals were not manufactured anywhere in the British Empire and were not likely to be produced here within any reasonable period. He hoped that the British chemical industry would start to conquer those fields at once.

Sir Alfred Mond, M.P., replying, referred to the petrol tax imposed under the Budget, and said that it might have a very far-reaching effect on the utilisation of our coal in the liquid form. These were early days to prophesy, but those who had had to study what was happening in such matters knew that very great progress had been made in the solution of the liquidification of coal. The problem to-day was more financial than technical. It could be solved at a price—and not such a very high price—to make the thing a commercial proposition. The encouragement the petrol duty would give in helping towards that solution would be very considerable.

GENERAL NOTES.

UNDERFEED STOKER COMPANY LIMITED.

During the past three months the above progressive company have secured over twenty important contracts from over twenty large companies and corporations at home and abroad, which is an indication of both progress on the part of the company and public appreciation of its products.

CHEMICALS AND ALLIED PRODUCTS IN CANADA IN 1926.

The Dominion Bureau of Statistics has just issued its final Report on the Manufactures of Chemical and Allied Products in Canada during the calendar year 1926. Several new features have been added to the Report, including summary statistics for the ten-year period in order to indicate progress made along chemical lines during the past decade; alphabetical lists of materials used and products made in the group as a whole, provide a convenient and comprehensive consolidation of data from the individual industries; and more detailed information on imports and exports has been included in the various chapters throughout the report.

A directory showing the names, addresses and plant locations of the firms reporting to the Bureau in this industry has been included, this shows the scope of the report and provides valuable publicity to the reporting firms.

Another feature of the report is the inclusion of summary statistics relating to those industries which use chemical processes in the fanufacture of products not usually described as chemicals. If the larger definition of the chemical industry be taken as including all industries using chemical processes the field covered represents not less than one-fifth of the aggregate of Canadian manufactures.

The total value of the products of Canada's 556 chemical manufacturing plants in 1926 was $122,589,526, the capi-

talisation of the industry being $133,407,891 and the number of employees 14,345. Nearly every industry in the chemical group had a higher output value in 1926 than in the previous year.

STATISTICAL ABSTRACT FOR THE UNITED KINGDOM, 1912-1926.

The 71st Number of the "Statistical Abstract for the United Kingdom for each of the years 1912 to 1926" (Cmd. 3084, price 6s. 6d. net) was placed on sale recently.

The Abstract, which covers a wide range of subjects, present in a summarised form a comprehrensive survey of the principal official statistics relating to the United Kingdom, and indicates the sources from which the information is obtained.

In the present number, an interesting summary table has been introduced which gives some of the most important figures at ten-yearly intervals from 1851 to 1921 and the corresponding figures for the year 1926. The following examples taken from this Summary, of the changes over a period of three-quarters of a century are of interest:

PETROLEUM AND HYDROCARBON OILS.

Revised notices regarding petroleum oils and hydrocarbon oils have been issued by the Commissioners of Customs and Excise.

SAFETY IN MINES RESEARCH BOARD.

Commodore H. Douglas King, M.P., Secretary for Mines, announces that he has appointed Mr. L. Holland and Mr. C. C. Reid to be additional members of the Committee created to investigate, under the general direction of the Safety in Mines Research Board, possible methods of reducing the number of accidents from falls of ground in coal mines.

The following additional members have also been appointed to the Committee for the purpose of the investigation which is about to be undertaken into the methods adopted in the coalfields of Lancashire, Cheshire and North Wales:—Mr. G. Culshaw, M. T. Evans, Mr. J. Farnum, Mr. E. A. Hughes, Mr. F. B. Lawson and Mr. F. H. Wilson.

Particulars.	Years. 1851.	1926.
Population (Great Britain) ... ... Thou.	20,817	43,964
Imperial Revenue ... ... Thou. £	56,307	805,701
Net Receipts from Customs and Excise Revenue ... ...Thou. £	37,597	239,988
Net receipts from Income Tax and Super Tax ... ... Thou. £	5,445	296,431
National Debt	816,717	7,622,946
Receipts from Rates (England and Wales) Thou. £	9,916	159,600
Coal Production ... ... Thou. Tons	64,661 (1854)	243,176 (1925)
Pig Iron Production ... ... Thou. Tons	2,701 (1852)	6,262 (1925)
Railway Passengers carried (excluding season ticket holders) ... ... Thou.	85,000	1,068,984 (Great Britain)
Railway Freight carried (excluding Live Stock) ... ... Thou. Tons	65,000 (1856)	315,951 (1925) (Great Britain)
Shipping entered in Foreign Trade:		
Sailing ... ... Thou. Net Tons	6,737	348
Steam and Motor ... ...Thou. Net Tons	1,135	81,930
Vessels on the Register:		
Sailing ... ... Thou. Net Tons	3,475	517
Steam and Motor ... ...Thou. Net Tons	187	11,390
External Trade:		
Imports ... ... Thou. £	152,389 (1854)	1,241,361
Exports of United Kingdom Produce and Manufactures ... ... Thou. £	97,185 (1854)	653,047
Exports of Imported Merchandise Thou. £	18,636 (1854)	125,495

The figures given above for the year 1926 are exclusive of particulars relating to the Irish Free State. For certain items, the earliest and latest years represented in the summary table are other than 1851 and 1926 and, in cases included above, the actual years are shown in brackets.

In comparing totals of money values, due regard must, of course, be paid to the considrable decrease in the purchasing power of money since 1851.

The statistical matter dealt with in the summary is supplemented by references to the more detailed tables in the body of the Abstract.

The tables relating to Local Taxation for England and Wales have been revised and expanded in the present issue of the Abstract and in their revised form will be of particular interest in view of the attention which Parliament is likely to devote to this subject in the near future. The sources of the receipts by local authorities are now shown in greater detail, and the expenditure on the several services as derived from (1) Local rates and (2) Government grants are distinguished. A statement showing the loan debt outstanding on each of the services controlled by local authorities is a further addition to this section.

Expectation of life at certain age groups is dealt with in a new table (No. 21). The figures have been compiled from the Reports of the Registrars-General and, covering the census years from 1871 to 191 show, which periods of life have been most affected by the improved expectation of life.

Proceedings and Notices of Societies.

THE CHEMICAL SOCIETY.

Thursday, May 17.

Neocyanine. By F. M. Hamer.

Neocyanine is the only cyanine dye of unknown constitution. It was originally obtained as a less soluble by-product in the preparation of 1 : 1′-diethyl-4 : 4′-carbocyanine iodide, but no details as to the method have been published, nor has any suggestion as to its structure been made. It was subsequently obtained as a by-product in the preparation of the 4 : 4′-carbocyanine by the action of ethyl orthoformate on lepidine ethiodide in the presence of pyridine. This method has now been applied to the preparation of *neocyanine ethiodide, ethobromide,* and *methobromide*; the best yield of neocyanine obtained was [illegible] yield of the 4 : 4′carbocyanine is increased at the expense of that of the neocyanine.

Syntheses of Cyclic Compaunds. Part III. The Reduction of Some Unsaturated Cyanoesters with Moist Aluminium Amalgam. A New Synthesis of Mono-substituted Malonic Acids and of ββ′β′β′-tetramethyladipic Acid. Further Evidence for the Multiplanar Configuration of the cycloheptane Ring. By I. Vogel.

The Action of Fluorine on Aqueous Solutions of Chromium and Manganese Salts. By F. Fichter and E. Brunner.

The authors describe a simple method of preparing and controlling the action of fluorine, and particularly its behaviour as an oxidising agent, on aqueous solutions of certain salts.

THE PHYSICAL SOCIETY.

Friday, April 27, 1928, at the Imperial College of Science, South Kensington, W. H. Eccles, D.Sc., F.R.S., presiding.

Experiments with Mercury Jets and the Phenomena Exhibited at their Impact with Steel and Glass. By Prof. Will C. Baker, M.A., Physics Department, Queen's University, Kingston, Ont., Canada. Communicated by Dr. Alan Ferguson in the absence of the Author.

Abstract.

As a light sphere is retained in a vertical jet of fluid in virtne of the change of momentum of the fluid produced by its adhesion to the sphere, it was thought that a steel sphere would not be retained in a vertical mercury jet, as there is no "wetting" of the steel by that fluid. Experiment showed that a given bicycle ball might or might not be retained by such a jet, as the speed of the jet (at a given angle of incidence) rose above or fell below a critical value for that ball.

Conditions were simplified by the use of cylindrical and of plane surfaces of steel, and an approximately constant time of adhesion between mercury and steel was found for various speeds of impact. This led to the explanation of the phenomenon in terms of the well-known instability of jets.

Discussion.

Dr. Eccles offered an alternative explanation of the ball-and-jet phenomenon. If the jet strikes the ball at a point away from the vertical axis the stream distributes itself unequally over the surface of the ball, and the thinner region of the stream loses velocity faster than the thicker region. Hence the [illegible]

and tends to restore the ball to the symmetrical position. The Author had experimented with steel and mercury in order to obtain an unwettable surface, but could he not more easily have waxed the surface of the balls ordinarily used? The paper reminded the speaker of a small slow-motion, variable-speed motor which he had once constructed, in which a water-jet of adjustable volume fell vertically on to a ball fixed to the lower end of an arm, the upper end of which was fixed to a shaft. The ball oscillated in the jet, and the consequent reciprocating motion of the shaft was rectified by means of rachet mechanism.

Mr. T. Smith said that Dr. Eccles' explanation should be tested quantitatively, since the low-pressure region of the stream rises higher, and so covers a wider area than the low-velocity region. The correctness of his explanation cannot, therefore, be decided qualitatively.

Dr. Ferguson said that he did not think that Osborne Reynolds, who first discussed the problem, had considered Bernoulli's theorem as a possible explanation. It was interesting to note, however, that Reynolds had described an experiment in which a disc forming the bob of a pendulum had been made to vibrate in a water-jet in the way mentioned by Dr. Eccles.

The Elastic Constants of Glass. By Edgar Philip Perman and William Donald Urry, University College, Cardiff.

Abstract.

(1) The coefficients of compressibility of soda-glass and Jena 16^{111} glass have been determined at six temperatures ranging from 30° C. to 80° C. (2) From experiments on the effect of external pressure only, Poisson's ratio has been determined, and hence the modulus of rigidity and Young's modulus.

A Valve-Maintained High-Frequency Induction Furnace and Some Notes on the Performance of Induction Furnaces. By G. Eric Bell, B.Sc., A.Inst.P., Physics Department, National Physical Laboratory, Teddington, Middelsex.

Abstract.

This paper is divided into two parts. In Part I the electrical design is given of a valve-operated high-frequency induction furnace, together with some details of its performance, and in Part II a theory of the behaviour of induction furnaces in general is developed, and some experimental results supporting the theory are given.

A Demonstration of the Blowing of Selenium Bubbles was given by Major C. E. S. Phillips, F.R.S.E.

The object in view is to obtain thin films of selenium for observation under a microscope. The selenium is heated in a beaker, and a blow-pipe having a slightly flared end is warmed to the same temperature by immersion in it. The blow-pipe is connected through a length of rubber tubing to the mouth of the operator, who withdraws the blow-pipe from the melt, and while testing the consistency of the adhering selenium by alternate air pressure and suction selects the correct moment for blowing the buble. The method is uncertain, but with practice good results can be obtained, and two large sausage-shaped bubbles were blown in the course of the demonstration. Pieces of the selenium film thus produced have the property of seizing or cold-welding when brought into quite light contact with one another.

GEOLOGICAL SOCIETY.

Wednesday, April 18, 1928.

The Succession and Structure of the Borrowdale Volcanic Series in Troutbeck, Kentmere, and the Western Part of Long Sleddale (Westmorland). By George Hoole Mitchell, Ph.D., M.Sc., F.G.S.

The area described lies in the eastern part of the Lake District south of the High Street range. It is drained by the Rivers Sprint, Kent, and Trout Beck, all of which flow in a southward direction.

The rocks described belong to the Borrowdale Volcanic Series. The estimated thickness of such members of the series as are exposed is approximately 3700 feet, but nowhere is the base seen. They are overlain unconformably by the Coniston Limestone Series. Nine subdivisions are recognised:

(i) Upper Rhyolites.
(h) Upper Andesites.
(g) Coarse tuffs.
(f) Wrengill Andesites.
(e) Kentmere Pike Rhyolites.
(d) Bedded tuffs, with andesite-flows.
(c) Harter Fell Andesites.
(b) Froswick Tuffs, with rhyolite-flow.
(a) Nan Bield Andesites.

There are also minor intrusions of rhyolite, quartz-porphyry, andesite, and lamprophyre.

The lava-flows range in composition from rhyolites to augite-andesites. In most cases flow-brecciation is evident and marked, while many of the andesites are intensely vesicular.

The tuffs, composed in the main of andesi-

fragments in abundance, and range from very fine-grained and well-bedded examples to ill-assorted agglomerates.

The rocks have been subjected to severe earth-movements. Two systems of folding are recognised, an earlier one of pre-Bala age and a later one of Devonian age. The former system, of simple character, shows axes trending in a north-north-easterly and south-south-westerly direction. In the later the folding was intense, with an east-north-easterly and west-south-westerly strike, while the pitch of the folds was determined by the folds of pre-Bala date. The rocks are steeply folded in the south-east of the area, and the folds are even overturned to the north. Northwards the folding is less severe, and is marked by the presence of a broad anticlinal fold.

No faulting of earlier date has been recognised, but several faults are referred to the Devonian system of earth-movements, while it is suggested that several north-and-south faults are of late-Carboniferous age.

The rocks are strongly cleaved, the strike of the cleavage coinciding with that of the Devonian folding.

The Geology of the Marquesas Islands (Central Pacific). By LAWRENCE JOHN CHUBB, M.Sc. (Communicated by the Secretary.)

The Marquesas Islands are situated in about 10° lat. S. and 140° long. W. With one doubtful exception all are of volcanic origin. The southernmost, Fatu Hiva, consists of a caldera composed chiefly of lava-flows, within which an ash-cone has been built up. The western half of the whole structure has disappeared, apparently owing to submergence by faulting. Motane is a small ash island. Tahuata is larger, and is also composed chiefly of ashes in its northern part; its south-eastern side has been faulted down. In Hiva Oa there are three great craters in the western part, some of the coasts are faulted, and there is an elevated plateau at a height of 1300 to 1500 feet above sea-level. Nuka Hiva has a structure similar to that of Fatu Hiva, and it bears a plateau at an elevation of 2600 feet.

A consideration of the directions of elongation of the islands, of the manner in which they are arranged, of the trends of the faulted coasts, and of the strikes of the dykes, leads to the conclusion that the group is situated, not on a crustal fold, but on a system of intersecting fissures.

The uplifted plateaux prove that elevation has occurred, but the embayment of the mouths of the streams that deeply dissect All the islands are surrounded by a shore-shelf, now standing, owing to a recent fall in sea-level, 3 or 4 feet above high-water mark.

It is suggested that the poor development of coral-reefs in the group is due chiefly to periodic chilling of the water by extensions of the cold Peruvian Current, connected with cyclic climatic changes.

THE INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

APRIL-MAY EXAMINATIONS.

PASS LIST.

Examination in General Chemistry for the Associateship :

Bessey, George Edward (Central Technical College, Birmingham; and Birkbeck College, London); Cox, Eric Ernest (Central Technical College, Birmingham); Davies, Emyr Conwy (Central Technical School, Liverpool); Elson, Leslie Alderman, B.Sc. (Lond.) Technical College, Loughborough; Foster, Frank, B.Sc. (Leeds) (The University, Leeds); Hopkinson, Gerald, A.M.C.T. (Wigan and District Mining and Technical College; and College of Technology, Manchester); McIntyre, Joseph (Royal Technical College, Glasgow); Rogans, Edward Stanley Fairfield (Central Technical School, Liverpool); Ward, Robert (Central Technical School, Liverpool); Wilson, Thomas Norman Gold (Royal Technical College, Glasgow).

Examination in General Chemistry for the Associateship held in Johannesburg in February, 1928.

Ochse, Oscar Lennox, B.Sc. (S.A.) (University College, Johannesburg.

Examination for the Fellowship :

In Branch E : The Chemistry, including Microscopy of Foods and Drugs, and of Water :

Back, Sydney, B.Sc. (Lond.); Barraclough, Arthur, B.Sc. (Lond.); Buist, Walter Ferguson, B.Sc. (Liv.); Bullock, Frederick Cecil, B.Sc. (Lond.); Chignell, Guy, B.Sc. (Lond.); Jones, Daniel Evans, M.Sc. (Wales); Leather, Alfred Norman, B.Sc. (Lond.); Vielcker, Eris ,A.R.C.S.; Walker, George Hugh, Ph.D. (Liv.).

In Branch F : Agricultural Chemistry :
Knowles, Frank.

In Branch G : Industrial Chemistry, with special reference to the Chemistry and Bacteriology of Water Supply :

Obituary.

PROF. EDGAR F. SMITH OF PENNSYLVANIA.

It is with profound regret that we learn from Mr. E. G. Eberle of the American Pharmaceutical Association of the death of our valued contributor, Prof. Edgar F. Smith, of the University of Pennsylvania, Philadelphia. This distinguished American chemist was a great admirer of British science and many of his original contributions to scientific knowledge were first published in this country. Reference to the *General Index to the First* 100 *Volumes of The Chemical News* shows that no less than 60 of his articles appeared in our first 100 volumes.

Prof. Smith's first contribution appeared in 1880 (vol. XLI. p. 219) and described new electrolytic results. Since then he has published many papers on general chemistry and made important discoveries in connection with the chemistry of tungstates. His last contribution to the subject, "Observations on the Soluble Meta-Tungstates," appeared iu *The Chemical News* of August last (19 and 26, vol. cxxxv, pp. 113 and 129).

As a biographer he has done much to create an interest in America in the history of chemistry and almost his last writing was an appreciative review of Dr. J. G. F. Druce's *Brief Outline of the History of Science* which appeared in *Chemical Education*, February, 1928.

Prof. Smith was 72 years of age.

FORTHCOMING EVENTS.

THE INSTITUTION OF GAS ENGINEERS.

Arrangements are well forward for the Cardiff Meeting of the Institution of Gas Engineers, opening on the 12 June, on which date H.R.H. The Prince of Wales, Honorary Life Member, is to unveil the beautifully-designed National Welsh War Memorial, erected in Cathays Park.

The Reception Committee of the Conference, recently held a meeting, at which the Lady Mayoress (Mrs. Howell) presided, when the final arrangements were approved.

Over seven hundred members are expected to attend. All the hotel accommodation has been taken up.

ROYAL INSTITUTION.

Friday, June 1.—C. Leonard Woolley: "The Results of the Further Excavations

ROYAL MICROSCOPICAL SOCIETY.

20, Hanover Square.

The Annual Pond Life and General Microscopical Exhibition will be held on Wednesday, June 6, in the Lecture Hall and Library from 7.30 to 10 p.m. Fellows willing to assist by bringing living or other specimens are asked to advice the Secretaries.

UNIVERSITY OF LONDON.

University College, Gower Street, London, W.C.1.

Thursday, May 31, at 5.30 p.m.—"The Centenary of Vincenzo Monti: the Poet of the Napoleonic Era in Italy." A public lecture by Professor Edmund G. Gardner, F.B.A.

Thursday, May 31, at 5.30 p.m.—"Chemical Kinetics." First of a Course of three public lectures by Professor Max Bodenstein, of the University of Berlin. May 31, June 1, and 4.

Chairman at the first lecture: Professor F. G. Donnan, C.B.E., F.R.S.

Friday, June 1, at 5.30 p.m.—"The Psychologist in the School." A public lecture by Professor C. Spearman, F.R.S.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

13,205.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of hydrogen peroxide. May 4th.

12,934.—Chemische Fabrik vorm. Sandoz. —Preparation of emetine. May 2nd.

12,620.—I. G. Farbenindustrie Akt.-Ges. Recovery of nitric acid. April 30th.

12,843.—L. H. Process, Ltd.—Extraction of hydrocarbons from bituminous materials. May 1st.

12,841.—Rosenheim, A.—Removing dissolved silicic acids from liquids. May 1st.

Specifications Published.

265,948.—Soc. Francaise de Catalyse Generalisee.—Production of methyl alcohol by catalysis.

265,636.—Geffcken, Dr. H., and Richter, Dr. H.—Devices for generating ultra-violet rays and activating

287,185.—Acetic acid. — Karpati, J., 15, Debroi Utca, and Hursch, M. G., 47, Csengery Utca, both in Budapest.

Acetic acid; acetaldehyde; catalytic agents, preparation of.—Acetic acid is produced by passing acetylene and oxygen into glacial acetic acid containing a mercury salt and cellulose fibres. Instead of cellulose fibres, vegetable fibrous materials such as saw-dust, shavings, or straw which have been heated in a stream of nitrogen and activated with high-pressure steam, may be used. The best yields are obtained when only the quantity of water required for the hydration of the acetylene is present, and this is preferably added in the form of dilute acetic acid. In an example an acetylene-*oxygen mixture is passed into acetic acid of* 96 per cent. strength containing mercury sulphate and cellulose, at 35-40° C., fermentation acetic acid being then added, and acetylene and oxygen being again supplied, or the fermentation acid may be supplied continuously. In another example the cellulose is replaced by hard-wood sawdust which has been heated in a stream of nitrogen and activated with steam, and the acetylene and oxygen are supplied alternately.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

SEDORMID.

489,862.—Chemical substances prepared for use in medicine and pharmacy.—The Hoffmann-La Roche Chemical Works Limited, The "Roche" Laboratories, 51, Bowes Road, London, N.13. May 9th.

GRAVITOL.

489,382.—Chemical substances prepared for use in medicine and pharmacy.——Bayer Products, Limited, 81 to 84, Basinghall Street, London, E.C.2. May 9th.

JUST PUBLISHED.

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CONTENTS. PAGE.

The Concept of Mass and the Laws of the Conservation of Matter and of Energy ... 337
By W. Tombrock.
The Part Played by British Workers in the Application of Fixed Nitrogen to the Soil ... 339
By Sir John Russell, D.Sc., F.R.S.
Use and Testing of Sphygmomanometers ... 340
General Notes :—
Petrol from Coal ... 344
Mines Administration in Spain ... 344
On the Preparation of Catalyser by the Electrolytic Corrosion of Nickel... 345
The Unsaturated Hydrocarbons in the Gases from the Carbonisation of Coal ... 345
By A. B. Manning, Ph.D., M.Sc., J. G. King, Ph.D., A.R.T.C., F.I.C., and F. S. Sinnatt, M.B.E. M.Sc., F.I.C.
Proceedings & Notices of Societies :—
The Royal Society ... 349
Geological Society ... 349
Institute of Metals ... 350
New Patents ... 351
New Trade Marks ... 352

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THE CONCEPT OF MASS AND THE LAWS OF THE CONSERVATION OF MATTER AND OF ENERGY.

By DR. W. TOMBROCK.

It is an illogical generalisation to attribute to the ultimate material particles gravitational attraction and electrical and magnetic attraction and repulsion. Indeed we can only observe these properties in combinations of material particles; they are produced probably, not to say certainly, only in and by these combinations, as a result of which it is illogical to attribute the above-mentioned properties to the particles separately. Naturally one may put the latter as a hypothesis, but then one commits the error of taking a practically incomprehensible supposition as the basis of one's explanation of nature; indeed how can two particles, taken by themselves, attract or repel one another?

We must certainly not lose sight of this simple and obvious thought, when we speak about the gravimetric or the electrical mass of a particle, since combined with these adjectives this mass becomes apparent in distinction to what I would call the actual mass of a particle.

What do we understand under the word "mass"?

Simply the "quantum of matter" and we think of this involuntarily, almost intuitively, as unalterable, so that the formation of something out of nothing appears to us as impossible; also the absolute disappearance of matter is incomprehensible to us.

Thus if we wish to found our explanation of nature on an understandable basis, we must take this mass, mark well, the supposed actual (true) mass, of the protons, electrons and ether-particles as constant.

So the law of the conservation of matter is simply a logical postulate for an understandable explanation of nature. One could call this so-called law an axiom just as well, indeed it is, on close examination, neither to be proved nor to be refuted.

Indeed the actual mass of an ultimate material particle by itself, and that is what matters, is unobservable.

By itself—one must think of the particle as in an ether-vacuum—any observation of an ultimate material particle is absolutely excluded. Only through contact with other material particles, through an "effect action" can this mass come into our perception.

So that a so-called observed mass can

is an apparent mass produced from an effect caused by contact of numerous material particles.

To lose sight of this point of view can lead to confusion. When we say : this mass is exclusively electrical, then we really mean that we can only observe it in an electrical effect or, in other words, can calculate it from an experiment of an electrical character. But when one says : this mass is exclusively electrical, then one thinks indeed : this is exclusively electricity and that is incorrect, since mass, the real mass, is matter, and matter is that which moves and is not electricity or weight...... electricity, magnetism, weight are, in accidental phenomena, forms of energy, properties of matter but not the matter itself.

Whoever will allow his thoughts to dwell calmly on this, will readily allow that it is certain that an observed or, more correctly expressed, calculated alteration in the (apparent) mass of a particle in no wise necessarily brings with it an alteration in the actual mass thereof. Indeed, why should it? It is quite well possible that the apparent electrical mass of a particle increases with increasing rotational or translational velocity or by altered experimental circumstances whilst yet the actual mass remains unaltered. So also one can safely say that a moving ultimate particle has no gravimetric mass or that its (apparent) gravimetric mass is zero, which signifies that this merely cannot be proved to be gravimetric, while yet the particle, merely because of the fact that it moves, must have a real mass. Motion indeed presupposes something which moves (matter).

But if we now find an alteration in the (apparent) mass of a proton, an electron, or an ether-particle, then there is every reason to suspect that our formulation of this mass in the case of question is inadequate, since indeed it appears to make our explanation of nature somewhat incomprehensible... In other words, it makes this explanation inacceptible. In any case it would be more understandable to us, if the formulation of this mass made it possible that the calculated (apparent) mass remained constant always in any kind of experiment whatsoever, and was thus in agreement with our axiom of the conservation of matter (real mass).

However, we must not lose sight of the fact that there exists the possibility that our formulation for the mass is correct, but some fundamental principle or hypothesis or other, that besides is implicitly or explicitly assumed in the calculation of the alteration of mass, will not do (for example the principle of the constancy of the energy.)

I remark incidentally here that in the case in which the two ideas of the conservation of matter and of the conservation of energy should come into conflict with one another, the latter principle would stand on the weak side. Energy indeed is accidental, a property or potential characteristic of matter, of which we can very well suppose that it decreases or vanishes, something which for matter itself is much more difficult, not to say impossible.

If now we premise that the object of our study of nature is to give au understandable explanation of material properties and phenomena, it is necessary that we should at once settle what we understand by the various technical terms; we shall be obliged to formulate our conceptions of these accurately and sharply.

What is matter?

What is energy?

Matter is the substratum of all physics; it is all that which moves. Matter is substantial.

Energy, according to the accepted approved definition, is an ability, a power, a potentiality, in short a property of matter which can be greater or less for the same mass (quantum of matter). Energy does not thus stand by itself, is not substantial but accidental.

Matter and energy are therefore quantities of different order.

The non-constancy of the energy is certainly not unacceptable to our understanding. We can quite well imagine that all matter should come to rest, indeed that all energy disappears.

So we should be able to think that a proton and an electron in definite circumstances of collision came to rest, so that their energy for a large part was got rid of, but what was firstly proton and what electron, that (the matter) still remains as such in our thoughts.

Also, it is thinkable that their energy—as a manner of speaking, since energy is not a substance—passed over to the surrounding ether-particles.

In fact, it is an alluring thought, that in the collisions of protons with electrons, in which proton-complexes would begin to form (birth of the atom) accompanied by the ejection of probably very strongly rotating electrons, ether-waves of short period would be produced (cosmic rays). But this is something quite different from saying : matter here passes over into energy......

Let us understand one another well here. Our understanding begs for the conservation

of matter, that is to say, of the ultimate material particles. But our understanding certainly does not demand the conservation of matter observable to the senses which is produced from the combination of the ultimate particles, protons, electrons and ether-particles. Theoretically these combinations can indeed be formed (in the interstellar spaces) and theoretically they can burst asunder (by the rarifaction of the ether)—consider the radioactive elements.

And in both cases similar disturbances in the ether may be considered to be produced...

But to say that in a collision of one proton against one electron, both *disappear* completely and pass over into something else which is thus called energy, is, to me, incomprehensible...... a preposterous explanation of nature.

But note—Matter occurs in various states. Matter can pass over from one state into another (water—ice). So also it may be *a priori* assumed that ether can be transformed into matter observable with the senses and *vice versa*. But that matter should be transformed into energy, given the definitions of mass and energy, is illogical.

Bergen op Zoom
(Holland).
April, 1928.

THE PART PLAYED BY BRITISH WORKERS IN THE APPLICATION OF FIXED NITROGEN TO THE SOIL.

By Sir John Rusell, D.Sc., F.R.S.
(Director of the Rotbamsted Experimental Station.)

(Abstract of paper given at the Chemical Industry Conference.)

Two British workers, Laws and Gilbert, have the distinction of being the first to demonstrate the advantage of adding nitrogen compounds to the soil for the purpose of promoting the growth of plants.

The field experiments carried out by these two men during their partnership of nearly 60 years, are of classical importance. They showed the effects of nitrogen compounds so sharply that they were continued year after year, and always on the same ground. Within a few years the experiments dealt with wheat, barley, oats and clover of various kinds, and meadow hay, each grown continuously on the same ground and the rotation of the crops also kept in the same land.

A feature of their work was the system of pared to take the risk of making any change, so that the plots go on as of old, and they are now by far the oldest experimental fields in the world.

Sir A. D. Hall, when Director, surveyed the whole of the results and published his summary and conclusions in "The Book of the Rothamsted Experiments" in 1905. After Sir Daniel left, the present Director recognised the impossibility of coping adequately with the mass of data by the older methods of averaging and inspection. A statistical department was therefore set up whose function was the examination of the whole of the results. Simultaneously, efforts were made to improve the accuracy and reliability of the field results. The new methods are based on two essential requirements; firstly, there must be several plots under each treatment, each plot being regarded as separate and distinct; and secondly, the plots must be set out in random order and not according to any bias, the arrangement being determined by the random drawing of cards on which the different treatments have been written.

The results thus obtained constitute good data in seeking correlation between crop yields and weather or soil conditions.

With these new methods a new subject has been opened up for investigation, namely, the effect of soil and climatic conditions on the effect of fertilisers. Its practical importance lies in the uncertainty hitherto attaching to the results of fertilisers. The results show that nitrogenous fertilisers are more steady in their actions than either phosphates or potassium salts.

The investigations indicate the possibility that if the general character of a season could be predicted, appropriate manurial schemes could be drawn up for mitigating its bad features and utilising to the fullest extent all its good ones.

In the meantime four important lines of investigation are being followed up :—

(1) The effect of seasonal conditions on the effectiveness of fertilisers.

(2) The relation between the quantity of fertiliser and the yield of crop.

(3) The effect of variations in time of application of the fertiliser on the composition of the crop.

(4) The influence of the fertiliser on the composition of the crop.

The modern investigations on nitrogenous fertilisers are showing agriculturists how to increase the quality of their crops and how also to effect modifications in composition and habit of growth that will enable them to

conditions of soil and climate. In modern conditions, crop production is always on the verge of unprofitableness so that the highest degree of efficiency in production must always be sought.

Among the various methods for increasing efficiency, the scientific use of fertilisers is one of considerable promise. Investigations are being pursued much more vigorously at the present time than at any previous period, thanks to the Research organisation of the Ministry of Agriculture and to the enlightened attitude of the large organisations dealing with fertilisers.

USE AND TESTING OF SPHYGMOMANOMETERS.

By J. L. Wilson, H. N. Eaton, and H. B. Henrickson.
(*U.S.A. Bureau of Standards*).

Abstract.

This publication contains a brief discussion of the characteristics of blood pressure in the human body, a description of the methods and instruments used in measuring arterial blood pressure, and *résumé* of results obtained in an investigation of the performance of the pressure indicators used in blood-pressure measurement. As a result of this investigation, standard tests were formulated and tolerances for accuracy of performance were established for use by the Bureau of Standards in testing blood-pressue gauges. The recommendations of leading medical authorities on blood pressure in the United States were given careful consideration in establishing the tolerances.

I. Introduction.

During the World War blood-pressure instruments were used extensively, not only in general practice but also in the examination of military and naval aviators, since the greatest importance is attached to the action of the heart at high altitudes. In 1917, at the request of the Surgeon General of the Army, an investigation of several types of sphygmomanometers was undertaken by the aeronautic instruments section of the Bureau of Standards. Later this bureau was requested by several manufacturers to recommend limits of error which should not be exceeded by the guages when subjected to specified tests. This resulted in a thorough investigation of the pressure indicators used with blood-pressure apparatus. Opinions were requested from the heads of hospitals and medical schools and from physiologists as to the required accuracy in blood-pressure measurement. The information received from these authorities was given due weight in specifying the tolerances. Throughout this investigation the most cordial co-operation has been rendered this bureau by phyicians and manufacturers, and occasion is here taken to acknowledge this assistance.

In 1921 an informal report of this investigation was issued in the form of a circular of the aeronautic instruments section of the Bureau of Standards. Since that time many blood-pressure gauges have been sent to this bureau by physicians, manufacturers, and various Government departments for examination. The present paper includes the results of tests on these instruments as well as those tested in the previous investigation. Since this publication has been prepared for the use of both manufacturers and physicians, it has been necessary to include material that may seem unnecessarily elementary to one or the other.

II. Blood- Pressure Measurement.

1.—*Characteristics of Blood Pressure.*

A knowledge of some of the simpler characteristics of blood pressure is essential to an understanding of the technique of its measurement and, consequently, of the conditions to which blood-pressure gauges are subjected in their use. The following discussion does not pretend to be an exhaustive treatment but sets forth the simpler aspects of the subject.

The human circulatory system consists of an intermittently working pump (the heart) forcing the blood through a system of subdividing elastic tubes (the arteries) to interlacing capillaries, and from these through another system of tubes (the veins) back to the pump. The work of the pump is expended in overcoming the peripheral friction of the tubes, by far the greatest part of which occurs in the arterioles and capillaries. Since the heart, like any simple pump, does not force out a steady stream of blood, a wave of increased pressure, which constitutes the pulse, starts through the system at each beat; but because of the elasticity of the arterial system, whereby its volume can increase with increased pressure, and because of the frictional resistance offered by the walls, especially those of the capillaries, the amplitude of the wave decreases as it gets farther from the heart until the pressure on the other side of the capillaries, in the venous system, is substantially free from fluctuations due to the arterial ...

The pressure at any point of the body is constantly varying rhythmically in several overlapping cycles. The first or cardiac cycle, the most important and having the greatest amplitude, is caused by the beat of the heart. The second or respiratory cycle, with an amplitude of 5 to 10 millimeters, is caused by the complicated effect of respiration which, by changing the intrathoracic and intraabdominal pressures, acts as an accessory pump with a much slower stroke. A third cycle, consisting of the so-called "Traube-Herring" waves of small amplitude, extends over several respiratory cycles. Its couse is unknown. In addition to these variations, the normal blood pressure is subject to many additional changes, often considerable, so that at least any single determination of the blood pressure, even if accurately made, is only an approximation to the average.

In ordinary clinical measurements the pressures at only two phases of the cardiac cycle are generally considered—the diastolic and the systolic pressures.

The diastolic pressure is the lowest pressure in the cardiac cycle. It occurs during the last of diastole, which extends from the end of one contraction of the heart to the beginning of the next and may be considered a measure of the peripheral resistance of the vascular system plus the factor due to the elastic contraction, or tone, of the walls of the vessels. This pressure varies, sometimes considerably, from diastole to diastole.

The systolic pressure, sometimes called the maximal pressure, is the greatest that occurs in the artery during systole; in other words, at the height of the contraction of the heart. It depends, as does the diastolic pressure, on the many factors influencing the general blood pressure.

The pulse pressure is simply the difference between the diastolic and the systolic pressures.

It does not fall within the purpose of this paper to discuss the range of normal blood pressure in any detail. What is normal in any case must be decided with the aid of the whole clinical picture of that case, and any arbitrary standards are very misleading. Particularly in old age is it hard to establish normal limits, since pathological conditions are then so usual that their absence might be considered abnormal.

Normal systolic pressures, determined in the customary way, can be said to range from 90 to 140 millimeters of mercury, although these limits can by no means be set as absolute. The majority of normal systolic pressures are between 110 and 130. Normal diastolic pressures are usually found to be between 60 and 100 millimeters of mercury, and the large majority occur between 70 and 90. In general, it can be stated that the diastolic pressure is normally about two-thirds of the systolic pressure.

2.—*Usual Method of Measuring Blood Pressure.*

All measurements of blood pressure in man are made without direct connection with a blood vessel. Pressure is applied over some artery, usually the bracrial artery above the elbow, until it is so compressed that the flow of blood is stopped entirely or persists only during a part of the cycle. When the compressing pressure is adjusted until the artery is closed except at the very peak of the arterial-pressure cycle, the external pressure is assumed to be equal to the systolic pressure; when it is adjusted until the artery is closed only at the lowest part of the arterial-pressure cycle, the external pressure is assumed to be equal to the diastolic pressure. The difficulty of recognising when the two above-mentioned conditions exist is responsible for much of the uncertainty which has been associated with blood-pressure measurements. Different criteria have been developed for this purpose, and will be discussed later.

In practically all modern devices the pressure is applied over the artery by inflating a rubber bag fastened around the arm or leg. The bag is connected to some kind of pressure indicator of the aneroid or mercury type, which is usually graduated to indicate the pressure in the bag in terms of the height in millimetres of a mercury column.

It is assumed that the tissues of the arm and the walls of the artery offer no resistance to compression. The pressure of the arm bag is then considered as being directly utilised in overcoming the pressure of the blood.

Investigations have been carried out to determine what part of the pressure in the arm bag is used in actually bending the walls of the artery, buried as it is beneath the muscles, and in closing its lumen. Results have not been consistent, but the error from this cause has been variously estimated at from 2 to 10 millimeters of mercury for arteries in a healthy condition.

It is evident that from the point of view of the physician, if not the physiologist, the actual pressure existing in the artery is of little moment. Long experience of many physicians has determined that certain pressures found clinically (that is, pressures in

the arm bag) are normal and others abnormal. For instance, if the physician found a blood pressure of 180 millimeters in his patient, he would recognise it as pathological and as having in that particular patient a certain diagnostic and pronostic value. Its value in this respect would not be less if it could be shown, by connecting the artery directly to a manometer, that the intraarterial pressure was much greater or less. It is only important that any existing fundamental error in the clinical technique shall be constant. As far as this error does vary in different patients, however, it lessens the significance of any variation from what is considered normal. In arteriosclerosis, for instance, it is possible that higher readings of pressure will be found than in cases with the same intraarterial pressure but with more easily compressible arteries. Some, however, believe that vasomomtor variations are more important than arteriosclerosis in introducing error.

To avoid, as far as possible, errors due to the pressure necessary to bend the walls of the artery, it has been shown that the arm bag should have an effective width of at least 12 centimeters for the arm of an adult and that the arm should be perfectly relaxed.

Some fear has been expressed that considerable error in reading may arise because the small fluctuations of pressure in the arm bag are not transmitted instantaneously to the manometer. It is true that changes of pressure are not quantitatively transmitted instantaneously in a closed system, but qualitative indications of the amount of the fluctuations are transmitted with a speed approximating that of sound from the arm bag to the manometer. When the oscillations are watched to determine the points of systolic or diastolic pressure no errors from this source need be feared. Considering the small volume of air in the ordinary blood-testing outfit, when properly arranged, it can safely be assumed that the pressure in the manometer is equal to that in the arm bag to within a few tenths of a millimeter, a quantity which is entirely negligible in measurements of this sort.

3.—*Technique of Blood-Pressure Measurement.*

The pressure bag is secured loosely about the arm or leg of the subject just above the elbow or knee. Except with small children, the arm is used. Connection is made with the manometer, and air is forced into the bag until the pressure in the apparatus is raised slightly above the point where all flow of blood in the artery is stopped. The air is then allowed to escape slowly, and the gauge reading of the pressures existing in the arm bag are read on the manometer as indicated by the particular criteria used by the observer for systolic and diastolic pressures.

The pressure in the arm bag should be raised and allowed to fall as quickly as is compatible with proper care in taking observations. This precaution is necessary in order to avoid a casomotor reaction, which may make the arterial walls less flexible, and also fatigue of the patient, which may influence the reading by causing contraction of the muscles of the arm.

It may be noticed that when the systolic or diastolic point is detected, if the leakage of air is suddenly stopped before a reading of the manometer is taken, the mercury column or the pointer of the gauge will immediately register a pressure slightly higher by an amount depending on the valume of the system and the rate of leak before the valve was closed. The opposite effect will appear when the pressure is increasing and the system is suddenly closed. No very great error, however, is to be feared from this effect.

4.—*Criteria for Systolic and Diastolic Pressures.*

Three methods have been generally used for determining the systolic and diastolic pressures; that is, the external pressures which have to be applied to the arm bag—first, to maintain the artery closed except at the highest point of the arterial cycle, and second, to allow the artery to remain open except at the lowest point of the arterial cycle. These are the palpation, the oscillation, and the auscultation methods. The criteria for the systolic and diastolic pressures are by no means exactly established, and especially is this true of the diastolic pressure.

(a) *Palpation Method.*—According to the palpation method, the systolic pressure is taken as that at which the pulse at the wrist, after having been stopped by inflation of the bag, is first felt when the pressure in the arm bag is falling. The selection of this point varies greatly with the skill of the physician, since the first pulses are very weak and may occur only once in several cardiac cycles. The diastolic pressure is assumed to be equal to that in the arm bag at the time when the pulses are strongest or "throbing." This criterion is very definite.

(b) *Oscillation Method.* — According to the oscillation method the two pressures are

determined by noting the variations in magnitude of the pressure changes in the arm bag caused by the flow of blood in the compressed artery. These set up pressure waves in the testin gsystem, thus causing the mercury column or the hand of the gauge to oscillate. The systolic pressure is taken as the pressure at which the first decided oscillations occur. These are caused by passage at the apex of the pressure wave of a thin stream of blood through the compressed artery, causing an abrupt change in its volume. The water-hammer effect of the blood against the wall of the artery at the point where it is closed causes oscillations at pressures far above the true systolic pressure, which must not be confused with those caused by the actual passage of blood through the artery. Ordinarily, at this point the excursion of the indicator suddenly becomes greater, but in many cases the transition is gradual, making this criterion also somewhat indefinite.

The diastolic pressure is considered by different authorities as the pressure at the first, the last, or the middle point of the series of oscillations of greatest amplitude. The basis for the assumption that the diastolic pressure is measured when the oscillations are greatest is that the change in the volume of the artery during the cardiac cycle, a measure of which is found in the fluctuation of pressure in the manometer, is greatest when the artery is completely closed by the arm bag only at the point of lowest arterial pressure; that is, at the diastolic pressure. This, however, has been seriously disputed.

(c) *Auscultation method*.—The auscultation method is at present considered by the majority of physicians to be the most dependable. The systolic and diastolic points are determined from the different sounds made by the blood in the artery as the artery is subjected to various degrees of compression. The sounds are heard by means of a stethoscope applied just below the arm band and have been carefully described by various investigators, some observers identifying more variations and phases than others. They have been classified in eight phases, occurring as the pressure in the arm bag falls. These are: (a) Silence; (b) murmers; (c) irregular snapping sounds; (d) regular rhythmic snapping sounds, growing increasingly sharper; (a) friction sounds; (f) regular rhythmic snapping sounds; (g) murmurs after an abrupt change from (f); and (h) silence.

The first of (d) and the first of (g) are usually taken as indications of the systolic pressures, respectively.

Numerous theories have been advanced in the attempt to explain the cause of sound production as the compressed artery opens and closes. Thus it is claimed that the sound is due to the sudden change in the tension of the arterial walls, that the compressed flesh surrounding the partion of the artery under the arm bag constitutes a resonating mass which is affected by vibrations of the arterial walls, and that it is due to the water-hammer effect of the blood as it strikes the closed artery or spurts through the partly opened artery and strikes the stagnant blood below the bag. The last theory appears to be the most probable of those which have been advanced and has been strengthened by the work of several experimenters, notably that of Erlanger.

5.—*Personal Equation and other Errors of Observation.*

If the manometer used with the blood-pressure outfit gave at all times an absolutely true indication of the pressure in the arm bag, large errors due to the personal equation of the physician would still occur. The possibility of these occurring is probably greatest in the case of the palpation method. Here the detection of the first pulse beats depends directly upon the skill of the observer, since the first pulses are very weak and irregular. It is quite possible for the attention to be so focused on the sensations in the balls of the fingers that the observer's own pulse is felt and mistaken for that of the patient. When comparing two physicians' results, it should be clearly understood whether the pressure at which the first pulse was felt or that at which the pulse was regular was chosen. Consistent recognition of the diastolic pressure by the palpatory method is very difficult.

When using the oscillation method, where a mercury column or the pointer of a gauge is observed, the physician must keep a mental image of the amplitude of the previous oscillations. For the determination of the systolic pressure he must make an instantaneous decision as to which is the first oscillation not due to the water-hammer effect, and for the diastolic pressure he must judge at which point the oscillations are greatest. The systolic pressure can be determined much more accurately than the diastolic pressure by the oscillation method.

The auscultation method yields more definite criteria for the systolic and diastolic pressures than do the others, but even when this method is used the point at which the pressure is read varies considerably with the habits and skill of the observer.

Considerable error necessarily arises in reading the height of the mercury column or the position of the hand of a gauge when it is falling continuously and is also oscillating. This error is greater the faster the fall of pressure. The error is increased if some separate device for magnifying or recording the oscillations must also be observed, in which case only a divided attention can be given to the manometer.

GENERAL NOTES.

PETROL FROM COAL.

The erection of a new low temperature carbonisation plant for providing London with smokeless fuel is announced in a circular letter issued to shareholders on May 17 by Low Temperature Carbonisation, Ltd., of London and Barnsley.

Reviewing the effect of the Budget proposals on the company's prospects, the circular states :—

" They are primarily of importanee inasmuch as they reflect the determination of the Government to foster the indnstry concerned with obtaining oil from British coal.

" The relief from duty of 4d per gallon on petrol is equivalent to a preference of nearly £5 per ton on spirit derived from coal, thus greatly improving the prospects of the British motor-spirit industry which hitherto has had to compete with very cheap imported oil.

" The prospects for colliery owners contemplating installing plant for dealing with their small coal are so much improved by the Budget proposals that it is almost certain that there will be a much wider adoption of low temperature carbonisation in the near future, with resultant benefits both to the coal industry and the company."

" Cracking " Oils.

" Work has been proceeding for some time," the circular adds, " with a view to evolving the most efficient method for the conversion of the crude coal oil into motor spirit and its other constituents. The Directors are working in close collaboration with the leading cracking and refining experts in England, Germany and America, and an early development of a satisfactory character is expected."

" The new works at Askern colliery (details of which have already been published) are being put in hand at once, while a second works will be erected in [illegible] to provide coalite for the London market. As these works will carbonise cheap water-borne coal it will be possible to supply the London market with smokeless fuel at a price well below the price of best house coal, whilst maintaining a very satisfactory profit for the Company. Negotiations are proceeding for further works both at home and abroad."

SPAIN.

Mines Administration.

The Department of Oversease Trade has received from the office of the Commercial Secretary at Madrid, the following information concerniug a Royal Decree, No. 697, dated 14th April, creating the " Direction-General of Mines and Combustibles." This will be under the control of the Ministry of Public Works, and will take over the National Fuel Council—until now controlled by the Presidency of the Council of Ministers —as at present constituted and with its present staff. It wil lalso take over the services carried out by the autonomous Section of Mines and Metallnrgical Industries of the Ministry of Public Works.

The new Direction-General of Mines and Combustibles will be responsible for the following :—

1. Geological and Mining Institute of Spain.
2. The Regulating Office and Superior Committee of exploitation of potassium salts.
3. The Special Mining Engineers' School.
4. The Chemical and Metalographical Laboratories.
5. The Fire-Damp Commission.
6. The Mining Districts.
7. The Regional and Provincial Delegations of the National Fuel Council.
8. The Schools of Inspectors of Mines and Master Miners and Smelters.

The central services controlled by the Director-General of Mines and Combustibles wil lbe divided into three sections, *i.e.*—

(1) Fuel.
(2) Geological research, Mining and subterranean Water investigations.
(3) Mines and Metallurgical industries—the Heads of which will be—The Vice-President of the Solid Fuel Committee, a post which must befilled by an Inspector-General or Chief Engineer of Mines; the Director of the Geological and Mining Institute of Spain, and in Inspector-General or Chief

COBALT PRODUCTION IN CANADA.

The Dominion Bureau of Statistics at Ottawa reports that the production of cobalt in Canada in 1927 reached 877,875 pounds, valued at $1,763,543, as compared with 664,778 pounds, worth $1,136,014 in 1926.

Canada produces about 55 per cent. of the world's output of this metal; the greater part of the remainder is derived from the Union Minière du Haut Katanga.

CANADA'S PLATINUM PRODUCTION.

Canada stands third in the world's production of the metals of the platinum group, larger amounts coming from Russia, and Colombia, South America. In British Columbia small quantities are found in placer deposits with alluvial gold and black sands; in Ontario these rare matals occur with the nickel-copper sulphide ores of the Sudbury district, from which they are obtained in the refining process.

ON THE PREPARATION OF CATALYSER BY THE ELECTROLYTIC CORROSION OF NICKEL.

By Sadao Iki.

(Journal of the Society of Chemical Industry, Tokyo Imperial University.)

The author has worked out a new method of obtaining nickel catalyser in pure and active form by the electrolytic corrosion of nickel in alkaline solution containing a small amount of alcohol. The results of the experiments are summarised as follows:

(1) As electrolyte, sodium hydroxide, potassium hydroxide, sodium carbonate and potassium carbonate are used with nearly the same results. The concentration of the solution is one of the most important factors. It must be very dilute (about 0.1-0.05 *N*) for good corrosion.

(2) In the solution consisting of alkali salt alone, the current efficiency of corrosion is very low and the product is oxidised from nickelous hydroxide to nickelic state. If a very small amount of alcohol (3-5 cc. of alcohol for 1 litre of the solution) the current efficiency increases remarkably, and the product is obtained in the form of nickelous hydroxide. Aldehyde acts in the same way as alcohol.

(3) When alkali hydroxide is used as electrolyte the nickel hydroxide produced is apt to adhere on the surface of nickel anode and increases the resistance of the current. This tendency is small when alkali carbonate is used as electrolyte.

(4) The current used in these experiments is the same as in ordinary electrolysis. The potential of 3-5 volts and the current density of 0.1-0.05 ampere per square centimetre are proper for this purpose. The current efficiency of corrosion decreases with increase of current density. Alternating current alone has but slight effect on the anode. The superimposing of alternating current on direct current does not increase the corrosion, on the contrary, it decreases the action in the author's experiments.

(5) The precipitate of nickel hydroxide can easily be separated from the alkali by electrolytic method.

(6) In the experiments with 0.05 *N* solution of sodium carbonate and 5 cc. of alcohol, in 1 litre and the current of 3-5 volts and 0.01 ampere per square centimeter, the efficiency of corrosion reaches 78 per cent.

(7) Lastly the author has stated his opinion on the commercial application of this method for the preparation of the catalyser.

OIL AND COLOUR CHEMISTS' ASSOCIATION.

Election of Officers and Members of Council.

The following Members have been elected as Officers of the Association for the Session 1928 to 1929 :—

President J. J. Fox; *Vice-Presidents*—H. D. Bradford, Noel Heaton, C. A. Klein, J. Russell Thornbery; *Hon. Secretary and Treasurer* S. G. Clifford; *Associate Member*—J. H. Grimshaw; *Ordinary Members*—W. Geary, J. B. Shaw (Country), R. P. L. Britton (Town).

THE "UNSATURATED HYDROCARBONS" IN THE GASES FROM THE CARBONISATION OF COAL.

By A. B. Manning, Ph.D., M.Sc., D.I.C.; J. G. King, Ph.D., A.R.T.C., F.I.C.; and F. S. Sinnatt, M.B.E., M.Sc., F.I.C.

(Technical Paper issued by the Department of Scientific Research, and published by H.M. Stationery Office, price 6d. net.)

In the introduction the authors state that a considerable amount of attention has been given to the conversion of the gaseous olefines into the corresponding alcohols and related compounds, especially glycols, while

the possibility of converting the diolefines, butadiene and its homologues, into rubber *gives additional interest to any method of* isolating those hydrocarbons or determining their proportions in any gas.

If the carbonisation of coal at lower temperatures for the production of smokeless fuel and tar is to become an established process it appears inevitable that the crude gas will be scrubbed for the recovery of the liquid compounds it contains. These vapours, unlike those of a high temperature gas, which consist chiefly of benzene, toluene, and xylene, will be more aliphatic in character and contain a relatively smaller amount of aromatic hydrocarbons. According to the convention of technical gas analysis the "unsaturated hydrocarbons" are those which are absorbed by bromine or by concentrated sulphuric acid. They include, therefore, aromatic hydrocarbons in addition to the olefines, diolefines, and acetylenes, but, in general, exclude the naphthenes.

Methods Previously Used.

The method usually employed to determine the unsaturated compounds present in a gas consists in converting them into their bromine compounds and subsequently separating the latter by fractional distillation.

This method, used recently by Sinnatt and Slater to determine the composition of the unsaturated hydrocarbons in an average sample of Manchester town's gas, gave—ethylene 83.8, 84.3; propylene 13.4, 11.8; butylene 1.7, 2.3; and amylene 1.0, 1.5 per cent. by volume. Arnold similarly for a gas from Lohberg coal carbonised at 575° C., found ethylene 57.2; propylene 24.5; butylene 14.2; amylene 4.1 per cent.; and in addition butadiene in the proportion of about half the amylene. Hock does not state explicitly the method he used for separating the olefines in a gas obtained by the carbonisation of coal from the Fürst Hardenberg mine in a large rotary retort at 500° C., but, most probably by the same method, he found ethylene 70; propylene 20; isobutylene 6; n-butylene 2; trimethylethylene and hexylene 2 per cent.

Schütz examined the bromine compounds prepared from a low temperature coal gas qualitatively and identified the bromides of ethylene, propylene, 1 : 2-butylene, 2 : 3-butylene and 1 : 2-pentene and butadiene.

Another method which has been used is based on the fractionation of the liquefied gases. In this way Wollers separated the individual saturated hydrocarbons, after [illegible] sulphuric acid containing 0.5 to 1 per cent. of vanadic acid, and repeated the process on a second sample of the gas after hydrogenation of the unsaturated hydrocarbons by passing a mixture of the gas with hydrogen over palladium. The difference in the amount of ethane, propane and butane provided data from which the amounts of ethylene, propylene and butylene respectively were calculated. Tropsch and Dittrich fractionated the whole of the hydrocarbons in such a way that eacr fraction contained not more than two of the unsaturated hydrocarbons. These were absorbed in 95 per cent .sulphuric acid and the proportion of the two determined by quantitative oxidation of the solution with potassium iodate. In this way, for example, Tropsch and Dittrich found for the olefines in a "gasöl," ethylene 8.9; propylene 20.6; butylene 4.0; amylene 3.0 per cent.

Present Method.

The method now put forward involves the separation of the unsaturated gases as their bromine compounds and the regeneration of the ethylene, propylene and butylene from the latter by the action of a zinc-copper couple. The resulting pas is then analysed by (*a*) absorption of propylene and butylene by 87 per cent. sulphuric acid and (*b*) combustion of a further quantity of the gas over copper oxide at 700° C. and determination of the volume of carbon dioxide produced.

About 10 cu. ft. of the gas to be analysed are taken for each complete determination. A value for the ratio, ethylene : propylene : butylene, can be obtained from a much smaller volume. The vapours are first removed from the gas by scrubbing with oil. This simplifies the subsequent examination of the bromine compounds, and, moreover, represents the usual practice in most commercial methods of treating low temperature and similar gases. About 1.5 litres of a gas oil of b.p. range 250°-350° C. are used to scrub 10 cu. ft. of gas. The amount of unsaturated gases which dissolves in the oil is practically negligible, but is recovered when the oil is distilled, and is converted into bromine compounds and added to the main bulk of the latter.

The results obtained by this method of analysis show in general an increase in quantity of all olefine hydrocarbons with rising temperature of carbonisation within the range of 400-700° C. The proportions of the three olefines in the gas produced at 600° C. are not unlike those produced by the [illegible]

in the Station low temperature vertical retorts, although the quantities per ton of coal are only about half in each case. It should be remembered that not only the retort system but the coal differs in each case, but it is probable that the former would have the greater effect in determining the amount of these hydrocarbons produced.

The gases produced by high temperature carbonisation were obtained when using a different coal, but in this case also it is probable that the retorting system would be the strongest determining factor. The amount of ethylene produced is considerably greater than by low temperature carbonisation, but the amounts of propylene and butylene are lower. This fact may be attributed to severe cracking in the retorts. As already stated the horizontal retorts show more cracking than the vertical retorts.

BUDGET HELPING BRITISH COAL OIL.

Encouraging Letter to Low Temperature Carbonisation Shareholders.

The following are extracts from a letter sent out over the signatures of Sir Arthur Wheeler, Chairman, and Whiston A. Bristow, Managing Director, of Low Temperature Carbonisation, Ltd. :—

(1) The proposals are primarily of importance inasmuch as they reflect the determination of the Government to foster the industry concerned with obtaining oil from British coal. This was emphasised by Mr. Winston Churchill, the Chancellor of the Exchequer, when explaining his Budget proposals in his speech broadcasted from the London Wireless Station.

(2) The relief from duty of fourpence per gallon on petrol is equivalent to a preference of nearly £5 per ton on spirit derived from coal thus greatly improving the prospects of the British motor spirit industry which hitherto has had to compete with very cheap imported oil.

(3) In addition to increasing the intrinsic value of the coal oils the exemption from duty will cause them to be in greater demand by reason of the fact that they will comprise the only raw material from which duty free spirit will be obtainable.

(4) As your company is the largest producer of coal oil in this country by the process of low temperaturs carbonisation, it follows that it will derive the most benefit from the new proposals and this is confirmed by the recent increase of activity in the

(5) The first result of the new proposals therefore will be to improve very considerably the prospects of the coal oil industry in which your company is the chief pioneer in this country.

In addition the prospects for colliery owners, contemplating installing plant for dealing with their small coal, are so much improved by these Budget proposals that it is almost certain that there will be a much wider adoption of low temperature carbonisation in the near future with resultant benefits both to the coal industry and your company.

PULVERISED FUEL : ITS USES APART FROM WATER TUBE BOILERS.

Mr. H. Heywood's Conclusions.

In the course of a paper on "Pulverised Fuel Systems," read recently before the Graduates' Section of the Institution of Mechanical Engineers, Mr. H. Heywood dealt, from within his own experience, with the application of pulverised coal to other than water tube boilers. His conclusions are summarised below.

The Lancashire boiler had valuable qualities as regards steam-reserve capacity and simplicity, and powdered fuel firing had greatly increased its efficiency. The grate was removed, and a short extension built on to the front of the furnace, so that a short-flame turbulent burner could fire down each flue. The bulk of the ash was deposited in the flues as a fine dust, being cleared out about every six weeks when working continuously, and a small quantity of molten slag ran out of the furnace extension.

A great field for pulverised fuel lay in its application to metallurgical furnaces, these being at present notoriously wasteful. In malleable-iron heating furnaces, arranged in pairs, each 45 feet long and capable of meltinfi 20 tons of metal in seven hours from cold, the fuel consumption on the pulverised system was about half the weight of the metal. The furnace temperature was over 1600° C., and the gases passed into the waste-heat boiler at 1400° C., leaving at 320° C.

In a continuous heating billet furnace, used for bringing steel billets 8 in. by 8 in. by 4 in. up to about 1250° C., previous to rolling into sectious, the billets were fed into the cold end, and the whole mass pushed up three feet at a time by a feeding mechanism. The coal dust was blown into

flame passed over the bridge and travelled across the bars. The temperature in the combustion chamber was very high, being over 1600° C., and most of the coal ash was run out as a slag from the bottom. Halfway along the furnace the temperature had dropped to 1260° C., while the gases left at 900° C. The gas temperature at the entrance to the stack was 430° C. The fuel consumption was 3.2 cwt. per ton of steel heated, including heating up and keeping in at night.

In a furnace used for heating piles of wrought-iron scrap, previous to rolling, the regenerative chambers had been retained in use since the conversion from hand-firing to pulverised fuel, and these chambers had kept fairly free from ash deposit, only having to be cleaned out every six months. Annealing furnaces for malleable castings had been kept burning continuously for 48 hours at a temperature of 900° C.

Pulverised fuel firing had also given satisfactory results in other than high temperature furnaces, such as heat treating furnaces working at 700° C.; cut-nail heating furnaces at 800° C.; gas temperature, and 600° C. metal temperature; and core-drying ovens.

As regards the burner, the original type giving a flat flame about 30 feet long was suitable for cement kilns and large water-tube boilers, but the new burner of the turbulent or dispersive type, giving a much shorter flame about 8 to 10 feet—could be used both on water-tube boilers and in the furnaces of Lancashire or Scotch boilers, and the experience with Lancashire boilers would lead to the application of powdered fuel on ship-board and possible on locomotives.

THE INSTITUTION OF GAS ENGINEERS.

The Institution of Gas Engineers, established in 1863, which has just deposited with the Privy Council its Petition to the King for the granting of a Royal Charter, is to be represented by its President and Honorary Secretary at the celebration of the Centenary of the granting of its Royal Charter to the Institution of Civil Engineers. The programme opens on Sunday, 3 June, with a service in Westminster Abbey. The reception of the British and foreign delegates takes place on the following day, and a conversazione will be held at the house of the Institution on Tuesday, 5 une. An engineering conference will be a feature of the centenary celebrations.

BOARD OF TRADE ANNOUNCEMENT.

Safeguarding of Key Industries.

Representations have been made to the Board of Trade under Section 10(5) of the Finance Act, 1926, regarding Yatren (iodo oxyquinoline sulphonic acid).

Section 10(5) of the Finance Act, 1926, is as follows :—

"The Treasury may by order exempt from the duty imposed by section one of the Safeguarding of Industries Act, 1921, as amended by this Act, for such period as may be specified in the order, any article in respect of which the Board of Trade are satisfied on a representation made by a consumer of that article that the article is not made in any part of His Majesty's Dominions in quantities which are substantial having regard to the consumption of that article for the time being in the United ingdom, and that there is no reasonable probability that the article will within a reasonable period be made in His Majesty's Dominions in such substantial quantities."

Any communications with respect to these representations should be addressed to the Principal Assistant Secretary, Industries and Manufactures Department, Board of Trade, Great George Street, S.W.1., within one month from the date of this notice.

WHOLESALE PRICES IN APRIL.

Board of Trade Index Number.

As measured at the Board of Trade, wholesale prices were higher, on the average in April than in March by 1.8 per cent., the index numbers for the two months being 86.0 and 84.5 respectively (1924 = 100). The index for all articles of food shows an advance of 4.4 per cent., cereals rising by 2.1 per cent., meat and fish by 4.1 per cent., and the group of other foods by 6.6 per cent. Owing mainly to an average increase of 3.3 per cent. in April compared with March in the price of cotton materials the index for industrial materials shows a rise of 0.3 per cent. Textile materials other than cotton rose on the average by 0.9 per cent., while miscellaneous industrial materials fell by 1.8 per cent. The averages for the two groups of metals and minerals show but small variations between the two months.

Proceedings and Notices of Societies.

ROYAL SOCIETY CONVERSAZIONE

The first of the two *conversazioni* given annually by the Royal Society—that for men only—was held on the night of May 17 at Burlington House, London. Many of the delegates to the Harvey celebrations were present.

Among the physical exhibits, which were rather outnumbered by those of biological interest, Sir William Bragg reproduced some experiments made by Faraday, and described in his unpublished laboratory notebooks, on the crispations or regular patterns formed on liquids lying on vibrating surfaces. Some tricks with stereoscopic vision were shown by Dr. R. S. Clay and Mr. T. H. Court, and experiments with solid dipleidoscope prisms by Prof. C. V. Boys. The fluorescenee of various minerals under ultra-violet light was exhibited by Dr. L. J. Spencer, of the Department of Mineralogy in the British Museum, and Lord Rayleigb showed peacock's feathers which had been exposed to rays of the same kind, the fading which occurs suggesting tbat the colours are due to pigments and not to the interference of light, as is generally supposed. Professor G. I. Taylor's experiments with bodies of different forms suspended in curved and converging streams of air were designed to verify predictions made beforehand by mathematical analysis and are in satisfactory accordance with them.

A fascinating machine, in which the spectator saw a stream of steel balls bouncing off a reflecting surface and disappearing down holes into various receptacles, was shown by the International Standard Electric Corporation; its purpose it to investigate problems in the distribution of traffic in automatic telephone exchanges, and it is said to give the required results much more quickly than they could be obtained by mathematical calculations of probability. From the National Physical Laboratory, Dr. W. Rosenhain and Mr. W. E. Prytherch sent a high-temperature electric furnace, in which the heat is generated by the resistance between pieces of graphite or carbon so effectively protected from oxidation by enclosure in a refractory sheath that there is no appreciable burning even after weeks of exposure to a temperature of 1,000° C.

The protection of heat-resisting steel against scaling by a preliminary oxidation treatment was illustrated by specimens shown by Sir Robert Hadfield, who also contributed examples of a machinable non-magnetic steel, having a yield-point of over 80 tons per sq. in. What he described as the oldest theodolite in the world, made by Humphrey Cole in 1574, was exhibited by Mr. G. H. Gabb.

Mr. Gabb was exhibiting for the 25th consecutive *conversazione*. The theodolite was first described by Leonard Digges in his Pantometria, 1571, a copy of which was also on view.

The School of Pharmacy of the Pharmaceutical Society of Great Britain showed specimens of various tropical plants and plant products.

Dr. Stanley Kemp gave a lecture on whaling in the Antarctic with illustrations of the scenery n the Falkland Islands.

GEOLOGICAL SOCIETY OF LONDON.

April 4, 1928.

The Analcite-Syenites and Associated Rocks of Ayrshire. By GEORGE WALTER TYRRELL, A.R.C.Sc., Ph.D., F.R.S.E., F.G.S., Lecturer in Geology in the University of Glasgow.

The analcite-syenites of Ayrshire occur in differentiated intrusions along with analcite-olivine-dolerites or crinanites, as stratiform bands, schlieren, and veins. The principal occurrence is at Howford Bridge, Mauchline, where analcite-syenite forms a considerable part of the sill. In the remaining three described occurrences (Dippol Burn, Trabboch Burn, and Prestwick) the analcite-syenite is restricted to schlieren and veins.

The Howford Bridge, Dippol Burn, and Trabboch Burn occurrences form sills intrusive into the Permian lavas and tuffs of the Mauchline basin; the Prestwick sill is intruded into sediments of Coal-Measure age. They all helong to the widespread suite of analcite-bearing igneous rocks of late-Carboniferous and Permian age in the West of Scotland.

The constituent minerals of these rocks are labradorite, sodic plagioclase, potash-oligoclase, olivine, titanaugite, ægirine, soda-amphiboles, ilmenits, along with analcite and certain zeolites. The most noteworthy mineralogical feature is the abundant occurrence of analcite, thomsonite, natrolite, and prehite, which must be regarded as late primary crystallisations from the magma.

Petrographically the rocks are divided into: (A) Olivine-analcite-dolerite (crinan-

ite), constituting the major portions of all the described occurrences; (B_1) Analcite-syenite, a coarse-grained, comparatively basic type, which occurs as bands, schlieren, and veins; and (B_2) Analcite-syenite, a perfelsic type, rich in analcite and other zeolites, and with abundant ægirine and soda-amphibole. This variety is found chiefly as veins. Analyses of crinanite and analcite-syenite illustrate the chemistry of these rocks.

The analcite-syenite differentiate is found towards the interior parts of the sills. The petrographical variations within the various intrusive bodies are ascribed to simple crystallisation-differentiation aided by the gravitative settling of titanaugite-ilmenite intergrowths. Several reaction-series, continuous and discontinuous, have been traced and these have been combined in a Goldschmidt diagram showing at one and the same time the parallel courses of crystallisation and differentiation. It is shown that a certain amount of lime is probably stored up in the residual liquor, along with the usual soda, potash, silica, water, and volatile constituents, leading to the final crystallisation of analcite, soda-lime zeolites, and prehnite.

A hypothesis for the development of schlieren and veins in the sills under discussion by the effects of the varying incidence of the pressure due to the superincumbent column of rick, upon a crystal-mesh filled with interstitial liquid, is framed. The liquid is believed to be progressively driven towards the centre of the sill, and also laterally towards those places where the pressure is compensated in various ways, so that free contraction of the crystallising mass can take place. The great development of analcite-syenits within the Howford Bridge sill is shown to be concomitant with the impoverishment of the associated crinanite in analcite; wheras in the other three sills, which contain relatively small developments of analcite-syenits, the crinanitic portions are relatively rich in analcite.

THE INSTITUTE OF METALS.

Forthcoming Visit to the United States.

At a General Meeting of Members of The Institute of Metals held in London on May 8, the following invitation was presented on behalf of the American Instiute of Mining and Metallurgical Engineers, by Mr. W. M. Corse, Honorary Corresponding Member to the Council for U.S.A.

Steel Divisions of the American Institute of Mining and Metallurgical Engineers, and believing firmly that science knows no boundaries and that by additions from many sources to the common pool of knowledge is the latter extended and deepened to the mutual benefit of all contributing, and that by international visits personal and professional bonds are built up that enhance the usefulness and prestige of professional men at the same time that they operate to strengthen the natural ties of history and ancestry between our two peoples,

"Now, therefore, on behalf of this Institute and by authority of its Board of Directors, I take pleasure in extending to you a most cordial invitation to visit and meet with us in this country at such time in 1932 as may be mutually found to be convenient.

(Signed) Geo. Otis Smith,

President, American Institute of Mining and Metallurgical Engineers."

The President of the Institute of Metals, Dr. W. Rosenhain, F.R.S., suitably acknowledged the receipt of the invitation, and indicated that it would be gladly accepted by the Institute.

It is understood that a good attendance of Members at the proposed meeting in the United States is expected as the ample notice of the date of the meeting will enable many persons to make the necessary arrangements to cross the Atlantic who could not do so were such a trip arranged at short notice.

The Council are endeavouring to arrange for an inclusive fare of about £100 to cover the entire cost of the trip. This, it is expected, will be of about five weeks' duration, and will take place in the autumn, both Canada and the United States being visited.

Further particulars can be obtained on application to Mr. G. Shaw Scott, M.Sc., Secretary, Institute of Metals, 36, Victoria Street, London, S.W.1.

NOTICES OF BOOKS.

Synthetic Organic Chemistry in the Study of Odorous Compounds. By Marston Taylor Bogert, Professor of Organic Chemistry, Columbia University. English price, 55s. New York: Columbia University Press; England, London: Mr. Humphrey Milford, Oxford University Press, Amen House, Warwick Square, E.C.4.

Scents, perfumes, odours are no modern

for is it not recorded that Joseph was captured and taken prisoner 3,700 years ago by a company of "traders" who were on their way from Gilead to Egypt with camel-loads of balm, myrrh and other olfactory stimulants? Then we know that the Wise Men of the East at the dawn of Christianity deemed frankincense and myrrh as worthy for presentation to the new-born King. In modern times the preparation of perfumes, etc., aided by scientific research, bas become a great and interesting industry. In the circumstances an authentic and comprehensive work such as the present substantial volume dealing with the subject, deserves and will, we are sure, receive, wide and careful study. It is well printed and handsomely bound.

NEW SYNTHETIC MOTOR FUEL IN GERMANY.

Important experiments are being conducted in Germany with a new synthetic motor fuel, manufactured from waste coke-oven gases by the Ruhr Chemicals Corporation, a company recently formed by 28 of the leading coal and steel interests of the Ruhr valley. The new fuel is methane gas, and is carried in compressed form in light steel tanks. It is understood that results obtained with it so far have been highly successful.

The methane used is a by-product in the production of synthetic nitrate fertilisers from coke-oven gas, which is the main business of the Ruhr Chemicals Corporation. Production of both is on an extremely cheap basis as the associated concerns have an annual surplus of approximately 9,000 million cubic metres of coke-oven gas on which to draw for raw material, all of which at present constitutes a dead loss. The processes used are the Casale and Concordia-Linde processes, of which the new company possesses a monopoly in Germany.

MICROSCOPICAL SOCIETY.

20, Hanover Square, London.

Pond Life and General Exhibition.

In the Lecture Hall and Library from 7.30 to 10 p.m., on Wednesday, June 6, Dr. R. J. Ludford and Mr. D. J. Scourfield will give a brief description of the Exhibits.

It is desirable that the Exhibition should embrace as many fresh-water types as possible, and specimens of the less well-known groups of Pond Life will be specially welcome.

Fellows willing to assist by bringing living

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

13,991.—Graesser - Monsanto Chemical Works, Ltd.—Separation, etc., of aromatic hydroxy acids. May 12th.

13,706.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of potassium. May 9th.

13,724, 13, 725.—Imperial Chemical Industries, Ltd.—Production of nitric acid. May 10th.

13,544.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of betaine thiocyanate. May 8th.

13,827.—I. G. Farbenindustrie Akt.-Ges. Manufacture of sulphonic acids of 6 - chloro - 2 - amino - 1 - methylbenzene. May 10th.

Specifications Published.

289,958.—I. G. Farbenindustrie Akt.-Ges. —Process for the manufacture of tetranitrodianthrone and of 2.7-dinitroanthrequinone therefrom.

290,045.—Moore, J. W., Polack, W. G., and Castner-Kellner Alkali Co. Ltd.—Manufacture of ammonium chloride crystals.

290,089.—Selden Co.—Methods of and apparatus for catalytically oxidising sulphur dioxide.

279,133.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of water soluble dinitroaryl-aminodiarylamines.

283,576.—Schering-Kalbaum Akt.-Ges. —Process for the manufacture of 2-amino-pyridines substituted in the 5-position by iodine.

Abstract Published.

287,604.—*Organic acids.* — Distillers Co., Ltd., 12, Torpichen Street, Edinburgh, and Peake, A. M., 319, Clapham Road, London.

Citric Acid.—Citric acid is obtained by the treatment of suitable materials of pectinous or similar nature with enzymes existing in citrus fruits. The enzymes which occur chiefly in the pith or inner layer of the rind of the fruits are extracted, for ex-

containing layer being first removed. The raw material to be treated may be the pulp of the fruit itself or substances such as the pulp of other fruits, gums, wood dextrin and sugars. The reaction is started in a slightly acid medium, the acidity being controlled as the action proceeds by the addition of calcium carbonate. Oxygen catalysts such as manganese or titanium salts may be added. Examples :To each litre of a mash containing 10 per cent. of pectinous material are added 0.5 per cent. of lemon pith, 1 per cent. of citric acid and 0.005 gram of manganese sulphate, and the mixture is maintained at 25° C. to 35° C. with aeration : lemon juice and pulp after fermentation, occurring spontaneously, or by the addition of yeasts which develop in the presence of citric acid, until sugar has disappeared and after alcohol has been distilled off, is heated with citrus fruit pith and an oxygen carrying salt, the citric acid content being thereby increased. Sterilisation of the raw materials may be necessary to prevent the growth of prejudicial organisms and this may be effected by boiling or the addition of antiseptics such as chloroform, toluene, etc.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

GENOVAX.

490,119.—Chemical substances prepared for use in medicine and pharmacy.—Genatosan, Limited, 48, Regent Street, Loughborough, Leicestershire. May 16th.

XOROX BRAND.

490,049.—Chemical substances prepared for use in medicine and pharmacy.—H. R. Napp, Ltd, 3 & 4, Clement's Inn, Kingsway, London, W.C.2. May 16th.

REGULOL.

489,435.—Chemical substances prepared for use in medicine and pharmacy.—Cuxson, Gerrard & Co., Ltd., 26,

JUST PUBLISHED.

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CONTENTS. PAGE.

The Rise of the New Quantum Mechanics 353
By N. M. Bligh, A.R.C.Sc., A.I.C.
Developments in the Heavy Chemical Industry 357
By Lt.-Col. C. P. Pollitt, D.S.O.
General Notes:—
Coal, Iron and Steel Production ... 358
French Chemical Industry 358
Carnegie Institute of Technology ... 359
Proceedings & Notices of Societies:—
The Royal Society 360
Institution of Petroleum Technologists 361
The Physical Society 363
The Optical Society 364
Base Exchange Water Softening 365
By a Well-Known Engineer.
New Patents and Trade Marks 367

ACCIDENTS IN BRITISH MINES.

There were 275 persons killed and 1,160 persons seriously injured by accidents in and about coal and metalliferous mines during the quarter. Thirteen of the deaths resulted from an explosion at the Haig Pit, Cumberland, on February 12. Further particulars are given for the previous quarter and the March quarter of 1927 are shown for comparison.

Killed.

March Quarter, 1928	275
„ „ 1927	325

Seriously Injured.

March Quarter, 1928	1,160
„ „ 1927	1,325

THE RISE OF THE NEW QUANTUM MECHANICS.

By N. M. BLIGH, A.R.C.Sc., A.I.C.

Since the introduction of the quantum theory into the considerations of theoretical physics a quarter of a century ago, its striking successes and very extensive range of applicability have been undeniable. At the same time, the whole problem of physical generalisation associated with the theory has been attended by numerous and apparently insurmountable difficulties. Expressed in their most general form these difficulties arose from the fact that, whereas the idea of discontinuity, fundamentally postulated by the quantum theory, was essential for the explanation of certain physical phenomena, the resulting break with classical theory left a number of equally important phenomena without satisfactory explanation, which the classical theory had adequately afforded. Physicists were in due course provided by the original quantum theory with an atomic model of great utility, which enabled them to co-ordinate knowledge of the structure of the chemical elements, and with the help of the correspondence principle, which in itself constituted an appeal to classical theory, to explain and classify a large field of experimental knowledge of spectra. For the satisfactory treatment, however, of reflection, refraction, diffraction and dispersion, the classical wave theory seemed essential, nor was any prospect of an outlet from this anomaly apparent. The "stationary states" of orbital electrons, and the frequency relation $E - E_r = h\nu$ were fundamental features of Bohr's quantised atomic model; or in other words, the motion of the electron in its orbit was governed by classical laws, but transitions between these orbits were governed by a law involving a discontinuity completely out of harmony with classical mechanics. On what lines would the ultimate elimination of this anomaly be effected? As the progress of theoretical physics in its widest sense is largely a process of generalisation of methods of expression, as exemplified by Relativity and the original quantum theory itself, as well as a development of mathematical methods, speculation arose as to whether the solution could be found in the employment of a new and more general theory of mechanics; or whether the whole validity of our methods of applying mechanics to physical problems would be found to be at fault, or again whether the difficulty would be traced to

or treatment of a physical picture of the atom, and to our method of regarding matter or "substance" as such; philosophical issues being thus involved. All three considerations play some part in the important work of the last two years, which marks a new epoch in quantum theory, and which it is now proposed to discuss.

Briefly, it may be said that the problem has been approached from two entirely different points of view; Heisenberg has formulated a new system of quantum mechanics in which the continuous variables of the classical theory are replaced by discreet quantities shown to be matrices, and Schrödinger, developing a most suggestive line of thought put forward by de Broglie, has evolved a system of wave mechanics. That these two systems have been shown to be equivalent is a striking and very satisfactory feature of the new advances. In this country Dirac has further co-ordinated and simplified the two systems by the application of a special quantum algebra which he has developed. Any hope, however, that a new form of theory reconciling the classical and quantum systems would lead to a simple mechanical picture of the phenomena involved, and a readily intelligible mathematical formulation seems doomed to disappointment; for while the quantum theory in its original form offered no serious mathematical difficulties to the average scientist, it would be idle to deny that the new mechanics is fairly complex, and that the theory of matrices and certain conceptions involved are somewhat unfamiliar. The matrix notation can be approached through a generalised vector, or tensor notation which is now tolerably familiar through, in particular, its application to the theory of Relativity.

Heisenberg[1], in 1925, in attempting to formulate an ideal or generalised system of classical dynamics, decided virtually to abandon the usual mechanical picture of an atomic model in space and time, and to avoid all quantities, such as mechanical or orbital frequencies, positions and periods of electrons, not subject to observation and experimental determination, and to devise a means of deriving observable transition frequencies, intensities and polarisations by reference to the stationary states, and not as on Bohr's theory by the application of the correspondence principle to orbital motion. He was guided by the previous work of Kramers[2] and himself on dispersion, in which experimentally observable magnitudes, *i.e.*, amplitudes and frequencies of emitted spectral lines were obtained by the application of the correspondence principle to results in terms of orbital amplitudes and frequencies obtained on classical grounds. On the classical theory the amplitudes and frequencies of a multiple periodic system can be found by expanding each x co-ordinate as a Fourier series, or one dimensional set of terms and applying the equations of motion; they are obtained as functions of a set of constants equal in number to the number of degrees of freedom of the system. In Heisenberg's treatment the dynamical system is described by a set of canonical variables derived from the Hamiltonian equation of the system, obeying certain quantum conditions and treated as a single entity or manifold. The harmonic components defining all possible vibrations of the atomic system take the form $a_{nm}e^{2\pi i\nu_{nm}t}$, and thus depend on two sets of integers n and m, not wholly analogous to the classical constants, but referring to two stationary states, or two sets of quantum numbers, while the solutions determining the amplitudes a_{nm} and the frequencies ν_{nm} are interconnected and must be considered as a whole. The atom is thus described by a two dimensional set of terms which form a quadratic scheme known as a matrix[3].

Matrices as a branch of algebra were introduced by British mathematicians, but subsequently developed by Continental workers, and may be regarded as a square or rectangular arrangement of terms resembling a determinant, but differing from the latter inasmuch as it is not simplified and evaluated in the same manner. Matrices can be dealt with by a set of algebraic rules, but a most important and fundamental feature is that the rule of multiplication is non-commutative, *i.e.*, in general, the multiplication of two matrices x and y results in a matrix xy whose terms are not the same as those of the matrix yx. The non-commutative dule is in harmony with the essential nature of a matrix as an array of terms, and not as a magnitude that can be simplified to a single numerical quantity.

The two dimensional matrix a takes the form

$$a = \begin{vmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{vmatrix}$$

[1] *Zeits. f. Phys.*, 1925, xxxiii, p. 879.

[3] Born and Jordan, *Zeits. f. Phys.*, 1925, xxxiv, p. 858.
Born, Heisenberg and Jordan. *Zeits. f.*

and in this theory each term of the matrix is to be multiplied by e^2 , the whole matrix being denoted shortly by $a_{nm}e^{2\pi i\nu_{nm}t}$, The unit matrix is

$$1 = \begin{vmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{vmatrix}$$

a diagonal matrix has the form

$$\begin{vmatrix} a_{11} & 0 & 0 \\ 0 & a_{22} & 0 \\ 0 & 0 & a_{33} \end{vmatrix}$$

In Heisenberg's matrices the diagonal terms are constants and are therefore independent of the time t, hence the diagonal terms of a matrix and a diagonal matrix itself correspond to a constant on the classical theory. If q represents the co-ordinate matrix and p the conjugate momentum matrix a dynamical system is described by
New business (sume assured)—

$$q = q_{nm}e^{2\pi i\nu_{nm}t}$$

$$p = p_{nm}e^{2\pi i\nu_{nm}t}$$

In developing this matrix scheme with the help of generalisations of the classical laws, it is found that the non-commutative multiplication law is the very one which allows the new analysis to be adapted to quantum requirements and admits the introduction of Planck's constant h, for all the diagonal terms of the matrix qp - pq are equal to $ih/2\pi$, which leads to the fundamental generalisation

$$qp - pq = \frac{ih}{2\pi}1.$$

where 1 is the unit matrix.

The powerful weapon provided by the new analysis has been seized upon by a number of workers, but early in 1926 Schrödinger[4] developed the suggestions of de Broglie into a system of wave mechanics equal in importance to the very different Heisenberg methods.

In Hamiltonian mechanics we have the fundamental analogy between Fermat's Principle of Least Time in optics, by which we can trace light ray paths provided the wave length of the light is small compared to the dimensions of the space in which it travels or the obstacles which it meets, and Maupertuis' Principle of Least Action in dynamics, by which we can trace the paths of material particles provided the linear dimensions of the paths are large. The break down of Fermat's principle resulting in diffraction effects is dealt with by the wave theory of optics, while for the break down of Maupertuis' principle in atomic regions we had previously no Hamiltonian analogy, and it is this analogy between the mechanics of atomic dimensions and the wave optics of small regions which Schrödinger's wave mechanics proposes to supply. De Broglie's argument[5] is that every 'mass particle,' element of energy, electron, etc., at rest is the centre of a pulsation through space, or a particle at rest in a space-time system of reference is to be regarded as a singularity of a pulsation. The symbol ψ defines the quantity, at present unspecified, which pulsates. If the 'element' is moving with velocity v relative to the observer, the pulsations instead of being simultaneous, will now appear as a phase-wave travelling in the direction of relative motion with a velocity c^2/v. The fact that this velocity is greater than that of light does not create a heoretical difficulty since it does not represent the velocity of an energy element, but

tial equation for a wave $\Delta^2\psi = \ddot{\psi}/u^2$ where u is the phase velocity and Δ^2 is the usual Laplace operator, or Δ^2 = div. grad. = $\frac{\delta^2}{\delta x^2} + \frac{\delta^2}{\delta y^2} + \frac{\delta^2}{\delta z^2}$ of the wave function ψ; the wave frequency being ν, ψ has a time factor $e^{2\pi i\nu t}$, so that $\ddot{\psi} = -4\pi^2\nu^2\psi$ and the original equation becomes

$$\Delta^2\psi + \frac{4\pi^2\nu^2}{u^2}\psi = 0$$

By classical analogy we must have $\nu = E/p$ and $\frac{1}{u^2} = \frac{2(E-V)}{E^2}$, where E is the total and V the potential energy. We then obtain Schrödinger's wave equation in the form :—

$$\Delta^2\psi + \frac{8\pi^2}{h^2}(E-V)\psi = 0$$

The next problem is to select values of the wave function ψ which shall satisfy the equation, and be subjected to certain continuity and boundary conditions. This is Schrödinger's "quantisation as a problem of characteristic values," and the important result is established that the set of values of ψ, the eigenfunctions, fulfilling these conditions demands a certain set of discreet

[4] *Ann. der. Phys.*, 1926, LXXIX, p. 361; 1926, LXXIX, p. 489; 1926, LXXIX, p. 734;.

[5] *Ann. de. Phys.*, 1925, x, p. 22.

of a phase. Starting from the usual differen-

values of E, the eigenwerte, which are the energies of the stationary states. The wave functions ψ_n corresponding to any one of these E_n specifies the atom for that stationary state.

Schrodinger originally derived his equation by a variation principle, for if $H(q, p) - E = 0$ is the ordinary Hamiltonian equation of the system, instead of the Hamilton-Jacobi equation $H(q, \frac{\delta S}{\delta q}) - E = 0$ for the characteristic function S, we put $S = K \log \psi$, where K is a constant of the dimensions of action, and thus obtain

$$H(q, \frac{K}{\psi} . \frac{\delta y}{\delta q}) - E = 0$$

From the appropriate Hamiltonian for a particle moving in three dimensional space, the wave equation is deduced, with the help of the relation $S = K \log \psi$ and a variation principle, in the form

$$\Delta^2\psi + \frac{2m}{K^2}(E-V)\psi = 0$$

Now in the case of the hydrogen atom ψ can be suitably chosen for all positive values of E, corresponding to the energy of the hyperbolic orbits, but for a discreet set only of negative values, given by $E_n = -me^4/2K^2n^2$ where n is an integer, corresponding to the Balmer terms, and determining a series of *finite orbits agreeing with Bohr's stationary* states if we put $K = h/2\pi$.

The electrical energy of a system can ordinarily be expressed as a volume integral, and it is this fact which suggests an interpretation for ψ. Schrödinger[6] proposes to interpret $\psi\bar{\psi}$, where $\bar{\psi}$ is the conjugate of ψ, as the electric volume density, thus replacing the electrons in the atom by an electric density which now makes it possible to deal with the behaviour of an atom under the influence of external fields.

Schrödinger next extends his theory[7] to the study of problems which are not directly soluble, but for which approximate solutions can be obtained analogously to the perturbation method of ordinary mechanics, and suggested by Lord Rayleigh's study of the vibrations of a string of slightly varying density. The mathematical theory is applied to the calculation of the intensities of the lines produced by the Stark effect on *the hydrogen lines, and it is shown that a* system can be expressed in terms of a quanfairly satisfactory agreement with experimental results is obtained, and is in general more satisfactory than the earlier results derived from the correspondence principle.

So far the wave equation has contained the potential energy V as a function of the coordinates alone and not involving the time. We can introduce a time derivative[8] instead of E by assuming that ψ has a time factor $e^{2\pi iEt/h}$, from which $\dot{\psi} = \frac{2\pi iE}{h}\psi$. On eliminating E from the wave equation we obtain

$$\Delta^2\psi - \frac{4\pi i}{h}\dot{\psi} - \frac{\delta\pi^2}{h^2}\psi = 0$$

This new equation can be applied to the problem of the perturbations of a conservative system due to a perturbing potential energy function which varies continuously with the time, and we are thus in a position to deal with the problem of dispersion. If the atom is subjected to light of frequency ν, linearly polarised along a definite axis taken as the direction of the electric light-vector, the potential energy of the electrons is $A(q)\cos 2\pi\nu t$, where q denotes the generalised co-ordinates of the atom. Taking V_0 for the potential energy of the undisturbed atom, we can write $V = V_0(q) + A(q) \cos 2\pi\nu t$, and substitute this value of V in the above wave equation. It is impossible here to give the calculations in detail, but a dispersion formula, identical with that of Kramers and Heisenberg is obtained, which involves a term giving the secondary radiation to which the original wave gives rise, and containing the Heisenberg combination frequencies; morever, information is furnished as to the specific conditions corresponding to the radiation of these frequencies.

The main theoretical contribution, made in this country, to the new quantum analysis is due to P. A. M. Dirac of Cambridge, who towards the end of 1925, and soon after the appearance of Heisenberg's original memoir, laid the basis of a new quantum *algebra which he has developed in a series* of illuminating papers, and by means of which he has been able to co-ordinate and simplify the theories of Heisenberg and Schrödinger in a manner which has proved extremely valuable. Dirac's primary advance[9] depends on his discovery that the quantum conditions for a multiple periodic

6 *Ann. der Phys.*, LXXX, p. 476.

7 *Ann. der. Phys.*, 1926, LXXX, p. 437.

tity analogous to a classical Poisson Bracket expression (hereafter referred to as a P.B.), thus avoiding the difficulties on the Heisenberg theory, of preserving the Hamiltonian form of the equations of motion by a theory of matrix differentiation. He investigates the fundamental theorems which are to be developed for application to a dynamical system to take the place of the classical theorems. They are based on Heisenberg's postulate, which we have already considered, that the commutative law of multiplication is not, for quantum variables, generally valid; that is xy is not equal to yx. It is necessary to define what relations may be taken over from the classical theory, and to establish the quantum conditions which must be satisfied by the canonical variables of a system. It is assumed that the equations of motion can be taken over, and the commutative multiplication law not being valid, we can take over any equation deducible from the equations of motion by any process not involving interchange of factors of a product. It is found that the most general operation analogous to differentiation which can be performed on a quantum variable is to take the difference of its Heisenberg product with some other quantum variable. This leads to an enquiry as to what this difference, *i.e.*, the expression $(xy-yx)$ corresponds on the classical theory. If x, y are functions of the coordinates of q and momenta p, the classical P.B. denoted by $[xy]$ has the form

$$\Sigma_r\left\{\frac{\delta\chi}{\delta q_r}\,\frac{\delta y}{\delta p_r}-\frac{\delta\chi}{\delta p_r}\,\frac{\delta\chi}{\delta q_r}\right\}$$

moreover it is not altered by a replacement of the variables p_r and q_r by another set of canonical variables. By introducing thus the action variables J_r and the angle variables ω_r, Dirac shows that $xy-yx$ corresponds to $ih/2\pi$ times the P.B. expression. Hence the generalised assumption is taken over into the quantum theory that the difference between the Heisenberg product of two quantum variables is $ih/2\pi$ times their P.B. expression, *i.e.* :—

$$xy - yx = ih/2\pi[xy] \qquad (1)$$

Applying the known properties of the classical P.B. to this result, Dirac takes over the fundamental generalised quantum conditions for the variables of a system, given by the equations :—

$$\left.\begin{aligned} q_rq_s - q_sq_r &= 0\\ p_rp_s - p_sp_r &= 0\\ q_rp_s - p_sq_r &= 0 \text{ if } r = s\\ q\,p_r - p\,q_r &= ih/2\pi \text{ i.e. } r = s \end{aligned}\right\}(2)$$

By the application of the equation (1) with the help of the Hamiltonian in the form

$\dot{x} = [xH]$ and Heisenberg's n and m, Dirac deduces the Bohr relation between frequencies and energy levels :—

$$H_{nn} - H_{mm} = h/2\pi.\omega(nm)$$

Since variables such as have been denoted by x and y do not obey the commutative law, they cannot be numbers in the ordinary mathematical sense, and Dirac[10] proposes to call such numbers q-numbers; by distinction ordinary numbers are designated c-numbers. Hense variables which are q-numbers appearing in the quantum solution of problems, when named in analogy to those of classical theory must in general be regarded as appearing in an analogous way to similarly named c-number variables in the classical treatment.

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[9] *Proc. Roy. Soc.*, A CIX, p. 642, Dec., 1925.

[10] *Proc. Roy. Soc.*, A CX, p. 561, March, 1926.

(*To be concluded.*)

DEVELOPMENTS IN THE HEAVY CHEMICAL INDUSTRY.

By Lt.-Col. C. P. Pollitt, D.S.O.

(Abstract of paper read before the Chemical Industry Conference, Tuesday, May 15 at 2.30 p.m., Chairman :—Dr. G. C. Clayton, M.P.)

The Heavy Chemical Industry underwent such fundamental changes in many directions during and after the War that there is a fairly sharp dividing line between pre-war and post-war practice although even before the War there were signs of the changes to be seen. The differences between pre-war and post-war conditions may be briefly summarised as follows.

A desire has grown up in manufacturing countries to be independent of imports where possible and research and invention have been greatly stimulated as a result of which synthetic processes are becoming more and more important. Economy in production of power from coal has reduced the relative importance of water power and finally the new processes have tended to encourage the growth of large manufacturing units with adequate organisations for research as well as for financing th business and disposing of the products. This latter tendency is likely to facilitate the manufacture and distribution.

The principal recent achievements of the Industry have been in connection with high pressure synthesis of Nitrogen products and certain organic chemicals such as methanol and the hydrogeneration of coal; the production of various cellulose products such as artificial silk and nitrated cellulose lacquers, etc; and certain new processes such as acetic acid from acetylene and sulphuric acid from Calcium Sulphate. All these new developments bring out clearly the great importance of research, both pure and applied.

Of the developments now taking place there is little doubt that the production of fertilisers and the study of agriculture to which it has led is from the world point of of view by far the most important.

GENERAL NOTES.

COAL, IRON AND STEEL.

Production and Wholesale Prices in Certain European Countries and in the United States.

In the six European countries named the total coal production in the first quarter of this year was 137,256,000 tons, representing an increase of 3,071,000 tons (or 2.3 per cent.) as compared with the December quarter of last year, but a reduction of 2,488,000 tons (or 1.8 per cent.) compared with the first quarter of 1927, when the British mining industry was exceptionally busy in consequence of the coal stoppage of the preceding year.

The total pig-iron production of the six European countries shewn in the table below amounted to 9,608,600 tons during the first quarter of this year, as compared with 9,442,300 tons in the December quarter of last year, and 9,016,000 tons in the March quarter of 1927. Each of the countries shown has increased its output over the March quarter of 1927. Of the increase of 592,600 tons, Germany accounted for 351,600 tons, France for 127,800 tons, and the Saar District for 42,800 tons.

The total steel output of the six European countries included in the table amounted to 10,659,300 tons in the March quarter, compared with 10,323,000 tons in the March quarter of last year and 10,231,100 tons in the December quarter. With the exception of the United Kingdom, all these countries shared in the advance over the first quarter of 1927. France, Germany and Luxemburg increased their outputs by 282,300 tons, 251,300 tons and 55,000 tons respectively. The output for the United Kingdom showed a reduction of 323,200 tons, but this was due in part at least, to the working off of old orders in the early months of 1927.

PETROLEUM.

Bisulphide of Carbon.

Among the 1928 Regulations for the Conveyance of Bisulphide of Carbon are the following :—

1. Bisulphide of carbon shall not be conveyed except :—

(a) In steel or iron containers each of a capacity not exceeding 50 gallons, constructed in accordance with the specification contained in the First Schedule, maintained in good condition and securely closed to prevent leakage, or

(b) In luted and tied-over stoppered bottles, each containing not more than 7 lbs., securely packed in strong wooden cases in sawdust, kieselguhr, or other suitable material. Each bottle shall be separated from other bottles by wooden partitions and the total weight of bisulphide of carbon in any one case shall not exceed 30 lbs., or

(c) In tank wagons, subject to the provisions of the regulations.

FRENCH CHEMICAL INDUSTRY.

Kuhlmann Combine Enters Synthetic Nitrate Field.

Important developments in the French chemical industry are foreshadowed in the report (published recently) of the Etablissements uhlmann, the big chemical and dyestuffs combine, which occupies in France the dominant position occupied by the I. G. Farbenindustrie in Germany, or by Imperial Chemicals in this country. This company has been very active recently particularly in the manufacture of synthetic fertilisers, and it is now announced that it has concluded agreements with several of the biggest coal companies in France, which will give the company control of immense supplies of surplus coke-oven gas for conversion into synthetic nitrate.

The process used in this synthetic nitrate industry is the Casale process, which is also

the process employed by the Ruhr Chemicals Corporation, a company recently formed by 28 of the leading Ruhr coal and steel concerns. It is significant that American bankers, Dillon Read & Co., of New York, are interested financially in both companies.

Etablissements Kuhlmann, which recently increased its capital to 200 million francs, reports a considerable increase in earnings for 1927, net profits after all deductions amounting to Frs. 34,011,855, as against Frs. 33,690,226 for 1926. Last year the company contributed nearly 80 per cent. of France's total dyestuffs requirements, and controlled 90 per cent. of the French dyestuffs output. In a variety of chemical industries, it has controlling interest, or large participation in 25 important companies.

CARNEGIE INSTITUTE OF TECHNOLOGY.

Between 60 and 70 scientists and fuel technologists in eleven different countries, it is announced, have tentatively accepted invitations to either speak or to read papers at the Second International Conference on Bituminous Coal, which will be held at the Carnegie Institute of Technology in Pittsburgh, Pa., during the week of November 19, 1928. The list includes about forty Europeans whom Dr. Thomas S. Baker, president of Carnegie Institute of Technology, personally invited while making his recent two-months' visit in Europe in the interests of the coal conference.

The purpose of the coming congress, an announcement points out, is similar to the one held in 1926 by the Carnegie Institute of Technology : to present the results of recent studies of coal that have to do with improved methods of utilisation and combustion. The program will include the discussion of low temperature distillation, high temperature distillation, coal tar products, power, smokeless fuel, complete gasification of coal, hydrogenation, pulverised fuel and its new applications, fixation of nitrogen, coal beneficiation, etc.

Upon his return from Europe in April, President Baker expressed the opinion that the second conference will be much larger in scope and importance than the first, and that the number of delegates from foreign countries will be considerably in excess of that at the 1926 meeting when thirteen different nations were represented.

FUTURE OF SYNTHETIC NITRATE INDUSTRY.

The *Financial News* says that the American Allied Chemical Company has been contemplating for over a year the erection of a large plant for the manufacture of ammonium sulphate at Hopewell, Virginia. The plans for this plant were completed and its construction was about to be commenced when the fear of overproduction in the fertiliser world led to the abandonment of the scheme. Recent research into the relation that is likely to exist between supply and demand during the coming years has, however, changed the aspect of the proposal, and the company has decided to go forward with the construction of one of the several units it had previously planned. This will have an annual output of between 80,000 and 100,000 tons of sulphate of ammonia.

If the Muscle Shoals proposal now before the Federal authorities goes through, the annual output of sulphate of ammonia in the United States will be increased by a further 100,000 tons per annum. It is thought likely, however, that if this scheme is approved by the Senate and the House of Representatives, it may well be vetoed by the President.

KEY INDUSTRIES DUTY ON CALCIUM BIPHOSPHATE.

The Tribunal appointed under Section 10 (4) of the Finance Act, 1926, to hear the complaint that calcium biphosphate (baking powder quality) has been improperly excluded from the lists of articles chargeable with duty under Part I. of the Safeguarding of Industries Act, 1921, has awarded in favour of the complainants.

Calcium biphosphate (baking powder quality) will accordingly be added to the list, and will he chargeable with duty on importation, as from June 4.

BRITISH COAL IN MARCH QUARTER.

Production of coal was 1½ million tons larger than in the preceding quarter, but shipments were half-a- million tons smaller. The average number of persons employed fell a further 17,000. For the first time in a post-war quarter not affected by export control or important mine stoppage shipments to Scandinavia fell below a million tons—a reflection of the effects of Polish competition. On the other hand exports to South America were higher than in any quarter since 1921.

FOREIGN COAL, IRON AND STEEL.

European coal outputs during the March quarter amounted to 137,256,000 tons, an increase of 3,071,000 tons or 2.3 per cent. as compared with the December quarer of 1927, but a reduction of 2,448,000 tons or 1.8 per cent. as compared with the March quarter of 1927. There was little change in the pig-iron productions and steel output.

ITALIAN FOREIGN TRADE.

Imports and exports during the first two months of the current year were valued at 3,268.1 million lire and 2,239.6 million lire, a trade deficit of 1,029 million lire as compared with 1,491.5 million lire for the coresponding period of 1927.

EMPLOYMENT AND PRODUCTION IN CANADA.

The Dominion Bureau of Statistics indices of employment and physical volume of production outline the remarkable expansion of Canadian business in the past three years. The index of employment in all industries has attained a new high level for the month, in each month since June, 1925, and the index of production has shown similar results since May, 1925. On March 1, 1928, the employment index reached 101.4 as compared with 96.3, 91.5 and 87.0 on the same date in the three previous years. The gain in the physical volume of production has been even more striking, reaching 165 in February, 1928, as compared with 148.0, 144.1 and 117.0 in the corresponding months of 1927, 1926 and 1925. The discrepancy between the increase in volume of production and employment, while partly due to increased efficiency of labour and improvement in methods of management, is largely attributable to the increased use of power in industrial production.

ELECTRIC ENERGY PRODUCTION.

According to the Royal Bank of Canada's statistics of electric energy production, the number of kilowatt hours produced during the first quarter of 1928 exceeded that of the corresponding period of 1927 by 15.4 per cent. and that of 1926 and 1925 by 44.0 per cent. and 77.7 per cent. respectively. In considering increases in energy production and consumption, it is of interest to keep in mind the fact that a large proportion of this growth is due to expanding industrial consumption.

VISIT OF HIS MAJESTY'S TRADE COMMISSIONER IN EAST AFRICA.

The Department of Overseas Trade announce that Col. W. H. Franklin, C.B.E. D.S.O., His Majesty's Trade Commissoner in East Africa will be in attendance at the offices of the Department for two weeks commencing on June 4. During that time he will be prepared to interview, by appointment, representatives of manufacturers and merchants interested in the export of British goods to the East African Dependencies.

Applications for interviews with Col. Franklin should be addressed at once to the Comptroller-General, Department of Overseas Trade, 35, Old Queen Street, London, S.W.1., quoting the reference 4311/1/28.

Proceedings and Notices of Societies

THE ROYAL SOCIETY.

The following papers were read at the meeting held on Thursday, June 7 :—

"The Emission of Secondary Electrons and the Excitation of Soft X-rays." By O. W. Richardson, F.R.S.

"Electron Emission in Intense Electric Fields." By R. H. Fowler, F.R.S., and L. Nordheim.

"The Excitation of Soft X-rays, II." By O. W. Richardson, F.R.S., and F. C. Chalklin.

The following papers were read in title only :—

"The Nodal Cubic Surfaces and the Surface from which they are Derived by Projection." By G. Timms. Communicated by H. F. Baker, F.R.S.

"On Quantitative Measurements in Frictional Electricity." By W. A. Macky. Communicated by R. Whiddington, F.R.S.

"An X-Ray Investigation of the Structure of Some Naphthalene Derivatives." By J. M. Robertson. Communicated by Sir William Bragg, F.R.S.

"A Critical Absorption Photometer for the Study of the Compton Effect." By C. V. Raman, F.R.S., and C. M. Sogani.

"The Wave Equation of the Electron." By C. G. Darwin, F.R.S.

"The Molecular Displacements in Diffusing Gas-Mixtures." By S. Chapman.

"A Series of Bessel Functions connected with the Lattice-points of an n dimensional Ellipsoid." By J. R. Wilton. Communicated by G. H. Hardy, F.R.S.

"On Line-Intervals of the Diurnal Magnetic Variations." By S. Chapman, F.R.S., and A. T. Price.

"The Influence of Vortices upon the Resistance Experienced by Solids moving through a Liquid." By W. G. Bickley. Communicated by G. I. Taylor, F.R.S.

"The Effect of Temperature on the Viscosity of Neon." By R. S. Edwards. Communicated by H. L. Callendar, F.R.S.

"The Distribution of Stress round a Circular Hole in a Plate." By W. G. Bickley. Communicated by E. G. Coker, F.R.S.

"On Phenomena Occurring in the Condensation of Atomic Streams on Surfaces." By J. D. Cockcroft. Communicated by Sir Ernest Rutherford, P.R.S.

"The Dependance of the Photographic Action of β-Rays on their Velocity." By C. D. Ellis and G. H. Aston. Communicated by Sir Ernest Rutherford, P.R.S.

"The Study of the Specific Resistance of Bismuth Crystals and its Change in Strong Magnetic Fields and some Allied Problems. Parts I, II and III." By P. Kapitza. Communicated by Sir Ernest Rutherford, P.R.S.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

The following paper was read at the meeting held on April 17, 1928 :—

Tube-Still Distillation. By C. H. S. Edmonds, M.Am.Soc.Mech.E., M.Am.Pet. Inst., M.Inst.P.T.

The distillation of crude oil constitutes the most important refining operation, and the past few years have witnessed very definite developments in the type of equipment installed for this purpose.

The shell still used either as a batch unit or as a continuous battery and fitted with more or less efficient fractionating equipment, is giving place to the modern tube still and positive type bubble tower yielding products of definite specifications in one operation, thus reducing substantially the amount of re-running and permitting relatively lower manufacturing costs for investment in equipment, direct fuel, process steam and loss of material. Quite naturally, during such development, there have been difficulties to overcome, but the refining industry may be permitted to congratulate itself that progress in its technical methods will bear comparison with other major industries.

The refiner demands distilling equipment that possesses flexibility to take advantage of different crude oils and varying market conditions and demand for products, and obviously such flexibility must at times be secured at some loss of commercial efficiency.

In general, tube-still distillation may be classified under two main heads :—

(1) The "once through" or single flash tube using either a single or multiple fractionating tower system, and (2) the "Step up" system involving the use of two or more tube stills and towers operated in series.

In addition there is the circulating type of still, but its usefulness for prime distillation is at the moment apparently somewhat limited, although it has a definite field in certain intermediate refinery operations.

Distilling Unit.

Leslie and Good show that a certain crude oil if heated to 600° F., and then vaporised, will yield 78 per cent. of distillate. The same crude oil, if vaporised by successive flash resulting from the formation of equilibrium between vapour and liquid at several temperatures, is only 59 per cent. at the same final temperature of 600° F. The importance of this fact is particularly evident when cutting deeply into the crude oil involving final temperatures of 750° F. to 850° F.

Furthermore, Leslie and Good show the total heat required, for the same per cent. vaporised is less by the "single flash" than by the "step up" or successive flash.

The vaporising portion of the fractionating tower separates the total oil into the liquid residue and a homogeneous vapour comprising all the overhead distillate products. The liquid residue or fuel oil passes through the heat exchangers and is cooled to a temperature at which it can be handled. The vapour passes up the tower and is divided or fractioned into the various products. The lighter ends are obviously at a temperature much above their boiling-point, and to secure these products in the form of liquid streams involves the removal of a certain amount of heat, and this is accomplished by the use of either a partial condenser located above the tower or by liquid reflux pumped back into the tower.

We see, therefore, that heat has first to be transferred into the oil and later removed from the oil, and perhaps the value of a distilling unit can be measured by the efficiency with which these two operations are carried out. Part of the necessary heat is introduced into the crude oil by utilising it as a cooling medium, the remainder being supplied by the burning of fuel in the combustion chamber of the tube still.

Tube Still.

Oil is not a good conductor of heat, and if overheated will break up into carbon and undesirable fixed gases at the expense of more valuable products; and it is therefore important to control the rate at which the surface absorbs heat from the furnace. Heat is absorbed in two different ways : by radiation from the furnace or heated brickwork, and by convection while in contact with the hot gases produced by combustion. One of the most important improvements in the design of tube stills has resulted from a fuller appreciation of the importance of radiant heat and the more complete proportioning of the radiant and convection heating surface. If heat is supplied to the surface at a rate beyond the capability of the oil to absorb it there is danger of overheating both the tubes and the oil, so that in the earlier type of tube still the fuel was burnt with considerable quantities of excess air. The thermal efficiency could only be improved by burning the fuel with less excess air resulting in a higher furnace temperature, and in some cases this was controlled by returning a portion of the flue gas to the furnace.

It has been found however, that if the absorbing surface is so located and proportioned that sufficient heat is absorbed by radiation, it is possible to prevent excessive furnace temperatures. Additional radiant surface has permitted the fuel to be burnt more efficiently, and at the same time the furnace temperature adjacent to the absorbing surface has been materially reduced.

A. G. Peterkin, junr., discussing "Tube-Still Distillation" (Eighth Annual Meeting American Petroleum Institute), has shown that when operating at a thermal efficiency of about 75 per cent. measured by comparing the input of heat into the oil with the heat liberated from the fuel burned, that the furnace temperatures adjacent to the radiant surface varied from 1680° F. to 1360° F. with a final oil temperature of 797° F. The temperature of the oil entering the tube still was 349° F., and the flue gases entering the stack were 490° F. The radiant surface comprised some 16 per cent. of the total surface and absorbed about 53 per cent. of the total heat.

Fractionating Tower.

The application of the tube still to refinery distillation necessitated the development of a fractionating tower that would continuously separate the homogeneous mass of vapour into the products required. ble, easy of control, and particularly capable of yielding specification products to obviate redistillation, which involves loss of material, increased capital expenditure and manufacturing costs.

Many types of fractionating equipment have been utilised, but there is a distinct trend towards the bubble tray tower as being more positive in action.

For any one method of operation there is a definite heat input into the tower, but as a portion of the vapour must be condensed and partially cooled to effect separation means are provided to remove this surplus heat. Partial condensers installed on the tower top have certain disadvantages, and more definite control is generally secured by pumping back liquid reflux to the top tray.

Crude oil is a mixture of a large number of constituents, and commercial refinery practice does not necessitate separation into pure products; the boiling range, specific gravity, flash-point and viscosity being the prinsipal physical characters necessitating control.

The liquid reflux generally adopted for the main control is the lightest cut yielded by the crude oil, and by discharging this on to the top bubble tray it absorbs heat from the vapour with which it comes into contact, resulting in the re-vapourising of the reflux and the condensation of a heavier vapour. The interchange of heat between the vapour ascending the tower and the liquid oil flowing down the tower is aided by bubbling the vapour through the oil on successive trays. There is a temperature gradient throughout the tower resulting from the introduction of cooling medium in the form of reflux flowing over the bubble trays, which may be regarded as cooling surface, bringing the hot and cold materials into intimate contact.

A single fractionating tower to yield a number of products is in effect a series of towers superimposed on each other, and in addition to the reflux introduced at the top tray it is necessary to provide additional reflux at each point where a liquid fraction is removed. To regulate the characteristics of the various fractions in commercial operation there are provided : "reboiling," or "stripping" sections, and these may be incorporated in the tower itself and such stripping sections may be fitted with superheated steam coils to give the required initial boiling-point or flash-point. Reference has already been made to the abiilty to vary the fractions, but sharpness of fractionation, particularly on the lighter products,

HEAT RECOVERY.

It has often been suggested that the ideal distilling unit would be almost self-supporting in so far as direct fuel is concerned. Disregarding fixed charges, fuel may easily be the most expensive refinery item, and any economy in this direction is pleasantly reflected in the annual balance sheet. The use of heat exchangers for cooling either the overhead distillate products or the fuel oil rsidue by means of the crude oil to be distilled may result in the latter absorbing a substantial part of the total heat required. The limiting point for heat recovery is the temperature differential between the cooling medium and the products being cooled, and there obviously is a point where this does not justify the additional surface necessary, but in actual practice it is not unusual to find that about 40 per cent. of the total heat liberated may be recovered.

CONCLUSION.

To the technologist the distillation of crude oil is a fascinating subject presenting endless possibilities for discussion, research and vision. To the refiner it is a commercial problem necessitating the greatest economy in handling a barrel of crude oil in order that the products may be marketed at a profit. Looking back ten years is helpful in realising the improvements in the art—perhaps the inability to look ahead ten years ahead is an advantage.

It is hoped that it has been demonstrated that tube-still distillation is a distinct advantage on the relatively older types of equipment, and the continued application of scientific facts, refinery experience and commonsense will result in still further development.

THE PHYSICAL SOCIETY.

Proceedings at the meeting held on Friday, May 11, 1928, at the Imperial College of Scienee, W. H. Eccles, D.Sc., F.R.S., in the chair :—

The following were elected Fellows of the Society—Elizabeth Mary Collins, B.Sc.; Norman Leslie Harris, B.Sc., A.Inst.P.

The following papers were read :—

The Amplitude of Sound Waves in Resonators. By E. G. RICHARDSON, B.A., M.Sc., Ph.D., University College, London.

After a consideration of the relations between the "pipe" and the "Helmholtz resonator," graphs of the variation of amplitude ,obtained by means of a hot-wire anemometer traversed through various types of resonator, are reproduced. By means of a calibrated manometer of the vibrating membrane type, some direct values of the impedance of orifices are obtained. Traverses across an orifice through which the air is vibrating in simple harmonic form are obtained with the hot wire : these show a tendency for the air to vibrate with greater amplitude in annuli remote from the centre of the orifice.

The Focus of a Gas-Filled X-ray Tube. By R. E. CLAY, M.Sc., Davy Faraday Research Laboratory, Royal Institution.

The importance of obtaining a sharp focus in an X-ray tube used for crystal analysis is emphasised. Pinhole photographs of the focus obtained with various radii of curvature of the cathode and various distances from the anticathode are discussed and the conclusion drawn that with the tubes of the type considered, a radius of about 2 cms. and a distance of 3 or 4 cms. are the best conditions.

A Demonstration of a Portable Electric Harmonic Analyser, showing Measurement of Harmonics in Voltage and Current Waves was given by R. Thornton Coe, B.A., M.Sc. Tech., A.M.I.E.E.

The instrument is used by the British Thomson-Houston Co., Ltd., for measuring small harmonics in the voltage or current waves. The determination of each harmonic is made separately from steady readings on two instruments, and only takes a few minutes. The amplitudes of small harmonics in voltage waves are found correct to at least 1/20th of 1 per cent. of the fundamental.

The method embodies the mathematical principle of obtaining the nth harmonic in a wave by multiplying by sin npt and integrating over a complete period.

The current to be analysed is passed through the moving coil of a dynamometer, while through the fixed coil is passed a sinusoidal "analysing current" of exactly the frequency of the harmonic under investigation : this is obtained by the use of a tuned circuit, valves and a synchronously driven contact disc. The phase of the analysing current is changed to give a maximum dynamometer reading D_{max}, where

$$D_{max} = kI_aI_n.$$

The analysing current I_a is measured on a thermal ammeter, and since k, the dynamometer D.C. calibration constant, is known, the reguired harmonic of current I_n can readily be calculated. A large current is analysed by connecting a suitable shunt across the dynamometer moving coil, while a voltage is analysed by connecting a fixed condenser in series. The apparatus was shown in operation upon the voltage wave-

form of current taken by a small auto-transformer supplying the synchronous motor of the analyser. The most prominent harmonics in the voltage wave were the 3rd, 5th and 7th, and also the 17th and 19th. The former (of amounts 2.1 per cent., 3.9 per cent., and 1,2.5 per cent. respectively *on a fundamental of 112 volts)* were due to the somewhat rectangular wave-form of flux distribution round the armature, while the latter (of amounts 3.0 per cent. and 1.5 per cent. respectively) were due to the ripple of flux caused by the slots in which the armature conductors are placed.

The transformer current wave showed large 3rd and 5th harmonics of amount 13.1 per cent. and 4.6 per cent. respectively on a fundamental of 5.2 amps. These large harmonics were due to the well-known distortion of the magnetising current wave of a transformer when the maximum ux-density is sufficient to saturate the iron core.

A general discussion followed the reading of each paper.

THE OPTICAL SOCIETY.

On delivering the Thomas Young Oration to the Optical Society on 16th May, 1928, Professor G. W. Ritchey paid tribute to the work of the great British Opticians and in particular acknowledged his indebtedness to the work of the late Doctor Common, which he said had been one of the main sources of inspiration for his own work.

The subject of the address was "The Modern Photographic Telescope" and Professor Ritchey first described his early work with the 2 ft. reflector at Yerkes, and his work in figuring, testing and using the great 60-inch and 100-inch mirrors at Mount Wilson. This part of the address was illustrated by several beautiful slides illustrating his work with these instruments. He pointed out that increased apertures would be necessary in order to study the details of star clusters, nebulæ, etc.

He explained the difficulties which had to be overcome in making, grinding, figuring and finally mounting the 100-inch mirror, and went on to describe his search for a method of making large mirrors which would obviate the difficulties due to a solid glass mirror, and his method of constructing the new cellular mirrors which he is carrying out at present in his Laboratory in Paris. He expressed the view that mirrors 6 metres and 10 metres in diameter were made possible by this new method of construction.

After describing the new Schwarzschild reflectors, he then proceeded to explain his projected method of conducting a photographic survey of the heavens on a greater scale than has yet been attained. This placed on a meridian to cover a zone 35 degrees North and South of the Equator, with which about 80 per cent. of the sky could be photographed. In these Observatories would be provided telescopes of the new types described, with mirrors 6 metres or even 10 metres in diameter, so arranged as to be readily adaptable to any required conditions. He concluded by giving a brief account of his search for sites for such Observatories, two of which he had already found in the United States. Slides of the beautiful canyon country in which one of these sites is placed showed not only the beauty and grandeur of the country, but also the marvellous clearness of the atmosphere, without which, it would be impossible to make full use of the great telescopes of the future.

A vote of thanks to Professor Ritchey for his address, ably moved by Lord Rayleigh and seconded by Mr. T. Smith, was carried with acclamation.

ON COPPER COMPLEX SALTS.

By Masuzo Shikata.

(Kyoto College of Agriculture, Kyota Imperial University.)

Introduction.

The application of the polarographic method to the microanalysis of copper has been shown in the previous paper. In that experiment, it has been found that the deposition potential of minute quantity of copper is to a certain degree influenced by the change of concentrations of potassium chloride and potassium sulphate. The present experiment has been undertaken in order to study such an abnormal relation as well as an occurrence of a maximum current in a current voltage curve, which has been often noticed in that experiment.

Experimental.

The galvanometer and the polarograph were the same, as were used in the researches on the reduction potentials.

A concentration of copper in the solution was determined by an electroanalysis.

All the experiments were carried out at the temperature of $25 \pm 0.5°C$.

The chief aim of the present experiment lay in establishing the relation between the deposition potential of copper and the con-

in finding the experimental bases of the maximum current phenomenon in the polarograms. Therefore we carried out experiments in the range of copper concentrations, which was suitable for those observations.

In Table I, the results of the electrolyses of the solutions of copper chloride, in the presence of various concentrations of LiCl.

SUMMARY OF THE RESULTS.

(1) The deposition potentials of copper complexes were measured with the dropping mercury cathode and the polarograph.

(2) The electrolyses were carried out in System $CuCl_2$—LiCl, System $CuCl_2$—KCl, System $CuCl_2$—NH_4Cl, System $CuSo_4$—Na_2SO_4—NaCl, System $CuSo_1$—$Al_2(SO_4)3$, System $CuSo_4$—$(NH_4)_2SO_4$, System $CuSO_4$—K_2SO_4 and in a cupric ammino-oxides solution.

(3) The equilibrium constant K was calculated, by assuming the formation of $CuCl'_3$ in System $CuCl_2$—IiCl.

$$K = \frac{[Cu^{\cdot\cdot}]\ [Cl']^3}{[CuCl'_3]}$$

For the same concentration of copper, K was found to be 3.98 × 10^{-3} (mean) for the different eoneentrations of LiCl between 0.05 and 1 n.

(4) For System $CuSO_4$—$MeSO_4$, the effect of a change of concentrations of a sulphate was less conspicuous than in the chloride complex.

(5) The formations of a maximum and a minimum current of intensities were observed. These phenomena were explained by the change of an adsorption of copper cimplex at the eleetrode.

(6) An height of a saturation curve, and its relation to the concentration of a neutral salt were discussed.

BASE EXCHANGE WATER SOFTENING.

APPLICATION TO STEAMSHIP PRACTICE.

By A WELL-KNOWN ENGINEER.

The softening and purifying of water for boiler feed purposes is one of the most important indications that steam generation to-day is essentially a branch of chemical engineering, and a long neglected field in this connection has been steamships. The average liner or other large vessel has of course to take on a considerable amount of fresh water for the boilers, and it is not perhaps realised by marine engineers this may be anything from say 5° to 40° total hardness depending on the port of call. Unanother particular trouble of the marine boiler plant, even apart from salt water contamination. It is interesting to note therefore, that the Paterson Engineering Co., Ltd., have just recently supplied to the Cunard Steamship Company three sets of their " Basex " water softeners, giving zero hardness to the make-up water, so that no trace of scale-forming material is added to the distilled water, which is equally important for the efficient operation of the " Scotch " and marine water tuhe boiler.

The three steamships are the ss. " Carmania," the ss. " Caronia," and the ss. " Mauretania," and in the latter case the complete plant is two " Basex " units each 2ft. 6ins. diameter with the usual brine tank preparing tank and steam jet elevator, and one 8ft. 6ins. diameter pressure filter with steam jet air injector and steam valve for the agitation of the filtering medium. The capacity of the plant is 1,400 gallons of zero hardness water per hour, with a total duty of 11,200 gallons between regeneration by means of salt solution, which only requires about 20 minutes.

For the "Carmania" and the "Caronia" the general details are the same, but the plants are slightly smaller, in each case being two " Basex " units of 2ft. diameter with brine tank, steam jet elevator, water meters, and one 2ft. 6ins. diameter pressure filter with steam jet injector and air valve, the capacity being 560 gallons of zero hardness water per hour and a total duty of 4,500 gallons between regeneration.

Basex is a natural mineral (sodium aluminium silicate), suitably graded and is claimed to possess highly reactive properties, with the usual resistance to acids and solution in water possessed by this general type of compound, as distinct from the artificial product.

CORRESPONDENCE.

EDUCATION AND INDUSTRY.

(*To the Editor of* THE CHEMICAL NEWS.)

Sir,—With reference to the recent announcement made by the President of the Board of Education it is interesting to note that special enquiries are to be made into the organisation of technical education, and this subject is of such vast importance to the future of our nation that I am emboldened to draw attention to a little book I published in 1926 under the title of " Compulsory Teaching of Chemistry in Schools "

Thirty years of industrial and commercial experience at home and on the Continent have convinced me that if we are to hold our own with the United States and Germany we must possess an adequate training in science, and this we can only acquire by the adoption of compulsory chemistry. Technical knowledge is based ultimately on chemistry which is the pivot of all our industries.

The twentieth century definitely marks the beginning of the scientific evolution of humanity and in order to maintain our position as a nation in the scientific and technical world we have only one course open to us, and that is to adopt the compulsory teaching of chemistry in our schools for both boys and girls on lines something similar to those I have set out in my book.

When women and girls possess a training in chemistry our rate of infantile mortality will drop; there will be less infectious and contagious disease and women themselves will enjoy a fuller life.

Chemistry is the *sesame* that opens all doors.

I agree that classical education is necessary and in my book I have endeavoured to show how compulsory teaching of chemistry can be adopted without encroaching on classical and other subjects as taught at present. I am bold enough to suggest to the Board of Education that if they would glance at the contents of my little book it is not impossible that they might find suggestions worthy of some consideration.

We have now come to a turning point in the history of the globe and the impetus which compulsory chemistry will give to our arts, industries, commerce and science and the quickening which will result in our moral and intellectual life are simply incalculable. Our descendants will only wonder why compulsory chemistry was not adopted at a much earlier date.

M. Koster.

83-91, Great Tichfield Street,
London, W.1.

SECRETARY OF THE ROYAL SOCIETY KNIGHTED.

Among the names in the Birthday Honours is that of Mr. James Hopwood Jeans, M.A., D.Sc., LL.D., F.R.S., Member of the Advisory Council for Scientific and Industrial Research, Secretary of the Royal

SCIENTIFIC ACHIEVEMENTS AT ILLINOIS UNIVERSITY.

The Department of Chemistry of the *Illinois University, Urbana*, has just compiled a *Bulletin* giving as reprints bound together the publications of the Inorganic Division. The 48 articles incorporated were originally published during 1924-27 and appeared in a wide range of journals. Mention may be made to a few of the more important ones, although it should be mentioned that all are valuable contributions to scientific literature.

The first paper is by Prof. W. A. Noyes, and deals with the need for the application of science for the well-being of all. Other general papers which were read at conferences aim at educating the public to the importance of the part played by chemical science in daily life, the need for more trained chemists, the advantages which would follow the adoption of the metric system of weights and measures, and other general subjects.

Recent advances in catalysis and other important papers by H. A. Neville deal with several aspects of the latest applications of physical chemistry, whilst the important researches by Prof. B. Smith Hopkins and his co-workers on the rare earth metals form a large section of the volume. These include his publications on the discovery of Illinium, the element of atomic number 61.

Prof. Smith Hopkins makes it clear that work in this field of inorganic chemistry is exceedingly difficult since the isolation of one element from sources composed cheifly or similar bodies and containing only traces of the new element is very tedious.

The collecting of these important contributions to our knowledge of inorganic chemistry into book form will assist research workers and others who are interested in the work done by the American scientists at Urbana.

COMMITTEE ON INDUSTRY AND TRADE.

"Survey of Metal Industries."

Th "Survey of Metal Industries" (which deals with the Iron and Steel, Engineering, Electrical Manufacturing, Shipbuilding, and Coal Industries) forms one of the four parts into which the Survey of Industries prepared by the Committe on Industry and Trade is divided. Its contents are based partly on official data, partly (and generally

supplied by the trades themselves, and partly on the results of other official and unofficial enquiries. In the case of Coal-Mining, as that industry has recently heen the subject of detailed investigation by a Royal Commission, the Committee have accepted the results of its investigations in lieu of direct evidence.

The Committee believe that for the most part their surveys constitute the most comprehensive statements of the kind that have been brought together in recent times, describing as they do the conditions under which each of the great industries dealt with has grown up; the development of its main branches as measured by the numbers employed, volume and value of production and growth of overseas trade; the structure and organisation of the industry; its situation with regard to such special problems as the supply of raw materials, the development of scientific research, standardisation, selling organisations, international agreements, etc.; and its whole position in relation to foreign competition, whether in overseas markets or at home.

These surveys of particular industries, taken with the studies of general factors in industrial efficiency, are absolutely essential in the Committee's view to a just appreciation of the position and tendencies of British trade and industry as a whole, and the Committee hope that the assembly of several surveys in one volume will facilitate the study of each industry's problems in the light of those faced (and, it may be, surmounted) by others.

The "Survey of Metal Industries" contains over 500 pages and includes a comprehensive index. It is published by H.M. Stationery Office (price 5s.), and copies can be obtained directly from them at Adastral House, Kingsway, London, W.C.2., 120, George Street, Edinburgh, York Street, Manchester, 1, St. Andrew's Crescent, Cardiff, 15, Donegal Square West, Belfast, or through any bookseller.

ROYAL INSTITUTION.

A General Meeting of the Members of the Royal Institution was held on Monday afternoon, June 4, Sir Arthur Keith, Treasurer and Vice-President, in the chair. The special thanks of the Members were returned to the Council of the Institution of Electrical Engineers for their gift of a portrait of Faraday after the painting by George Harcourt, R.A. Gen. Sir John Maxwell and Sydney Walton were elected

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

14,453.—Altwegg, J. — Rendering stable the combination of 4-dimethyl-amino-1-phenyl-2-3-dimethyl 5-pyrazolone with butyl chloral hydrate. May 16.

14,318.—Carughi, A. — Manufacture of chloride of lime. May 15.

14,415.—Dandridge, A. G.—Manufacture of chemical products. May 16.

14,646.—Neumann, E.—Manufacture of aldol and crotonic aldehyde. May 18.

14,659.—I. G. Farbenindustries Akt.-Ges.-Manufacture of sulphuric acid, &c. from gypsum &c. May 18.

Specifications Published.

290,316.—Seldon Co.—Catalytic oxidation of sulphur dioxide.

274,023.—Soc. D'Etudes Minieres et Industrielles.—Manufacture of ammonia.

277,938. Haynes, P. E. Manufacture of carbon dioxide.

290,523.—Goldschmidt, Dr. S. —Oxidation of ethyl alcohol.

290,518.—Liljenroth, F. G.—Method of producing ammonium phosphate or mixed fertilisers containing ammonium phosphate by leaching of raw phosphate.

Abstract Published.

287,967.—Acyl and alkyl phenols.—Pope, Sit, W. J., Holmesdale, Brooklands Avenue, Cambridge.

Acyl derivatives of resorcinol and hydroquinone are obtained by treating the monoacidic esters derived from fatty acids containing more than two carbon atoms with a condensing agent, such as magnesium chloride, zinc chloride, aluminium chloride, ferric chloride, stannic chloride, sulphuric acid or phosphoric acid. The corresponding alkyl hydroquinones and resorcinols may be obtained by redection of the products, *e.g.*, with zinc amalgam and hydrochloric acid in the known manner. In examples, (1) hydroquinone monopropionate, obtained by warming hydroquinone with propionic

propionylhydroquinone, (2) isobutyric chloride is warmed with resorcinol and the crude monoisobutyrate obtained is heated with zinc chloride; the product is isobutyrylresorcinol, which on reduction with zinc amalgam and hydrochloric acid yields isobutylresorcinol, (3) resorcinol is heated with caproic chloride or anhydride and the reaction mixture, or the isolated monocaproate, is heated with zinc chloride to yield caproylresorcinol, (4) resorcinol monolaurate, obtained by warming resorcinol with lauric chloride is heated with zinc chloride to form laurylresorcinol, and (5) stearic acid is converted into the chloride by warming with thionyl chloride heated with resorcinol, and the product is heated with zinc chloride to form stearylresorcinol. Specifications 8373/89 and 9428/89 are referred to.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

IODISTICK.

487,938.—Chemical substances prepared for use in medicine and pharmacy.—H. R. Napp, Limited, 3 and 4, Clements Inn, Kingsway, London, W.C.2. May 9th.

DIGIPAN.

487,840.—Chemical substances prepared for use in medicine and pharmacy.—Mermann Temmler, trading as Temmlerwerke Vereingte Chemische Fabriken, Flugplatz 6, Berlin-Johannisthal, Germany. May 9th.

GENOCAIN.

490,117.—Chemical substances prepared for use in medicine and pharmacy.—Genatosan, Ltd., 43, Regent Street, Loughborough, Leicestershire. May 16th.

FIBRO-LUSIL.

489,177.—Chemical substances prepared for use in medicine and pharmacy, but not including liniments, and not including any goods of a like kind to liniments.—William Clarence Tuke, 38, Walbrook, London, E.C.4. May

JUST PUBLISHED.

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CONTENTS. PAGE.

The Rise of the New Quantum Mechanics ... 369
By N. M. Bligh, A.R.C.Sc., A.I.C.
Adsorbent Materials of Use in Chemical Industry ... 372
By M. Schofield, M.A., B.Sc.
Chemical Study of Low Temperature Tar ... 373
By Sir Hugo Hirst, Bart.
Unexplored Branches of Industry in Czechoslovakia ... 374
General Notes ... 374
Proceedings & Notices of Societies:—
The Royal Society ... 377
The Chemical Society ... 379
Physical Society ... 380
Geological Society ... 380
New Patents ... 383
New Trade Marks ... 384

GENERAL INDEX TO THE
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This large volume contains a detailed Index to the first 100 volumes of the *Chemical News*, and will be found of great value to all interested in Chemical, Engineering, Electrical and General Scientific subjects. It has been compiled with great care, is handsomely bound in red cloth, and has been produced at great expenditure of time, labour and money. Carriage paid, Great Britain, 21/- net; Carriage paid to Foreign Countries and the Colonies, 23/- net.

THE RISE OF THE NEW QUANTUM MECHANICS.

By N. M. BLIGH, A.R.C.Sc., A.I.C.

(Continued from last week.)

Dirac next applies the q-number theory to the study of the orbital motion of the electron in the hydrogen atom. It is assumed that the Hamiltonian of this system is the same function of the dynamical variables and on the classical theory, when expressed in Cartesian co-ordinates. A transformation is made to polar co-ordinates using q-numbers, which leads to a result which is not identical with the classical form. After a lengthy and ingenious calculation, Dirac achieves the notable success of arriving at the Bohr formula for the Balmer terms.

A close analogy to the methods of the classical theory is preserved in the extension of the new quantum algebra to the problem of a number of electrons moving in a central field of force.[11] As in the former, a contact transformation is obtained from Cartesian co-ordinates and momenta of the electrons to a set of canonical variables, so here a similar simplification is effected by the introduction of certain real canonical variables, and employing algebraical treatment based on the fundamental non-commutative multiplication law, and in harmony with the previously developed methods of quantum algebra. The case is considered of a system containing one or two electrons, which by a suitable generalisation is extended to numbers of electrons greater than two, and transformation equations are deduced. The new variables include k, the action variable defined by the magnitude of the angular momentum of the electron, j the action variable defined by the total angular momentum in the case of a system with two or more electrons, and their respective canonical conjugates which are regarded as angle variables. It is found that each $k = m$, the magnitude of the angular momentum, but is related to it my $m^2 = (k + \frac{1}{2}h)(k - \frac{1}{2}h)$, while a similar relation holds between j and the resultant angular momentum of the whole system. By substituting for the action variables a set of c-numbers fixing a stationary state, in order finally to obtain physical results, the theory is found to give the correct boundary values for the action variables, and it also

[11] *Proc. Roy. Soc.*, A cxi, p. 281, May, 1926.

allows the deduction of half integral values of k corresponding to the S, P, D, etc. spectroscopic terms. We are also given the correct Landé formula for the energy of the stationary states in a weak magnetic field, as well as Kronig's results for the relative intensities of multiplet lines and their components in a weak magnetic field.

In extending his methods to relativity quantum mechanics,[12] Dirac adopts the general principle of introducing canonical variables into the corresponding classical theory, which is reformulated with P.B.'s in place of differential equations. For a dynamical system of u degrees of freedom for which the Hamiltonian H involves the time explicitly, the time must, by the principle of relativity be treated like the other variables, and must therefore be a q-number; t and $-E$, where E is the energy of the system, are taken as a new pair of conjugate variables satisfying equations analogous to (2). The dynamical system is now determined by a Hamiltonian equation $H - E = 0$, between the $(2u + 2)$ variables, instead of by a Hamiltonian function. The subsequent development of the quantum mechanics of moving systems is applied to the theory of the Compton effect,[13] starting from a consideration of a free electron subjected to plane polarised monochromatic radiation, which is considered to form with the electron, a dynamical system ,while the scattered radiation, regarded as an emission spectrum is to be determined by the new methods. The equations found from the conservation of momentum and energy on Compton's light quantum theory give the same values for the frequency of the scattered radiation and the recoil momentum of the electron as on the present theory, and Dirac's calculations of the intensity of the scattered radiation for various angles of scattering show good agreement with experimental results, while his relation differs only slightly from Compton's formula.

One of the most striking features of the new quantum methods is the essential equivalence in their results, of lines of progress so fundamentally different as Heisenberg's matrix theory and Schrödinger's wave mechanics. In relation to these two theories Dirac's next great contribution[14] was to apply his methods so as to furnish a simplified means of calculating the Heisenberg matrices through the medium of a symbolic algebra. If $H(qp) - E = 0$ is the Hamiltonian equation for a system, the general form of Schrödinger's wave equation for the wave function ψ is :—

$$\{H(q, \frac{ih}{2\pi}\frac{\partial}{\partial q}) - E\}\psi = 0$$

where p in the previous equation is replaced by the operator $\frac{ih}{2\pi}\frac{\partial}{\partial q}$ and ψ is assumed to contain a time factor. A further generalisation is obtained by treating the time t and its conjugate momentum $(-E)$ on the same footing as the other variables. The q's and t are taken as ordinary mathematical variables, and the p's and E as differential operators,

$$p_r = -\frac{ih}{2\pi}\frac{\partial}{\partial q_r} \qquad -E = -\frac{ih}{2\pi}\frac{\partial}{\partial t}$$

The differential operator is to operate on all that occurs on its right hand side in the term in which it appears, and thus any function of the p's and q's, E and t can be reduced to a function of q's and t only. Let $F\psi = 0$, where ψ is a function of the q's and t only. The general solution $\psi = \Sigma c_n\psi_n$ of this equation can be expressed in terms of a discreet or continuous set of eigenfunctions ψ_n. It is next shown that any constant of integration of the dynamical system can be represented by a matrix whose elements are constants ,there being one row and column corresponding to each eigenfunction ψ_n; e.g., if a is such a constant of integration and $a\psi_n$ is a solution of $F\psi = 0$, so that $a\psi_n = \Sigma_m\psi_m a_{mn}$, then a_{mn} are the elements of the matrix representing a. To obtain Heisenberg's unique matrices we suppose the Hamiltonian does not contain the time explicitly, and choose the ψ's so as to make the matrix representing E a diagonal matrix. We must let the function x of the dynamical variables be one that does not involve the time explicitly, then putting $x\psi_n = \Sigma_m x_{mn}\psi_m$, where the x_{mn}'s are functions of time only, it is finally shown that $x_{mn} = a_{mn}\, e^{2\pi\iota/h(E_m - E_n)t}$ whence $x_{mn} = a_{mn}e^{2\pi\iota\nu(mn)}$ and $h\nu(mn) = E_m - E_n$, thus

[12] *Proc. Roy Soc.*, A CXI, p. 405, June, 1926.

[13] For a Schrödinger treatment of the Compton effect. cp. Gordon. *Zeits. f. Phys.*, 1926, XL, p. 117; Schrödinger, *Ann. der Phys.*, 1927, LXXXII, p. 257.

[14] *Proc. Roy Soc.*, A CXII, p. 661; Oct., 1926.

showing how to express the q-number x as a Heisenberg matrix. Considerations are explained which justify us in regarding ψ's as representing stationary states of an atomic system with definite values of the energy and angular momentum.

The theory which we have been considering is applied to a system containing several particles, such as an atom with several electrons, and Dirac shows that for an atom with two electrons, the possible choice of ψ's satisfying the necessary conditions gives, as one alternative Pauli's exclusion principle (that no two electrons in an atom can have the same four quantum numbers), and as another, extended to the analogous problem of an ideal gas, gives the Einstein-Bose statistical mechanics.

The solution of a problem in Heisenberg's mechanics furnishes a multiplicity of matrix schemes satisfying Dirac's quantum conditions, while the physical interpretation of a q-number involves its expression as a diagonal matrix whose diagonal terms are so-called "characteristic values of the q-number. These values are c-numbers and can therefore be compared with experiment. Dirac[15] deduces general transformation equations between two matrix schemes, and from these proceeds to show in particular how it is possible to find the matrix scheme which makes any function of the dynamical variables a diagonal matrix. He also deduces a form of the Schrödinger equation depending on the transformation scheme.

A theory of emmission and adsorption of radiation[16] is developed by assuming that the energy and phase of each of the Fourier components of the radiation are dynamical variables, and are q-numbers satisfying the standard conditions. The interaction with an atomic system of a field of radiation having a discrete set of degrees of freedom is described by a Hamiltonian, and account can now be taken of the effect of the radiation on the atom and the reaction of the atom on the field, which conld not be done in a previous treatment when the energy and phase were taken as c-numbers. Finally it is shown that the correct laws for emission and absorption can be deduced. Extending the principles of the above method to the theory of dispersion, Dirac was able to obtain the Kramers-Heisenberg formula.

To overcome certain difficulties associated with spectral multiplets, as well as for theoretical reasons, Uhlenbeck and Goudsmit[17] introduced the notion of a quantised spinning electron, which is assumed to have a definite magnetic moment and angular momentum of spin. In one of his most recent papers Dirac[18] postulates that the necessity for such an assumption points to some incompleteness in the previous methods of applying quantum mechanics to the point-charge electron, and shows that agreement with observation can be obtained by a correct relativistic application to the point-charge electron of the general quantum methods which he has developed, so that the essential features of the spinning electron follow naturally, without the need of arbitrary assumptions. To obtain the desired result he deduces a wave equation of the form $(H-E)\psi = 0$, which is invariant under a Lorentz transformation and is equivalent to the wave equation deduced from the relativity Hamiltonian of the classical theory in the limit of large quantum numbers. The equation contains dynamical variables (spin variables) which are q-numbers describing some internal motion of the electron, and taken to be the spin of the previous theories. The method adopted gives a correct result for the energy levels obtained for the motion of an electron in a central Coulomb field of force. It is now necessary to employ only three quantum numbers to define the orbit of an electron in an atom, *i.e.*, the usual n, a number j which determines the magnitude of the resultant angular momentum for an electron moving in a central field of force, and u the magnetic quantum number determining the component of the total angular momentum in some specified direction. The old azimuthal number k is not now required, for the various series of spectral terms are described by a single quantum number j taking both positive and negative integral values[19]; while the selection rule for j is shown to be equivalent to the two usual selection rules for j and k. The relativistic intensities of lines of a multiplet, and the anomalous Zeeman effect for weak and strong fields also give results in agreement with previous theories.

Within the scope of this survey it has not been possible to give more than a brief outline of the general methods of the new schemes of quantum analysis and some indication of the results which have been reached. The utility of the new theories has

[15] *Proc. Roy. Soc.* A CXIII, p. 621, Jan., 1927.

[16] *Proc. Roy. Soc.*, A. CXIV, p. 243, March, 1927.

[17] *Naturwissensch*, XLVII, p. 958, 1925; *Nature*, CXVII, p. 264, 1926.

[18] *Proc. Roy. Soc.*, A CXVII, p. 610, Feb., 1928.

attracted the attention of a large number of investigators, whose work has been divided between an extension and simplification of the pure analytic methods, and their application to physical problems, and has been the means of eliminating, in such applications as have so far been worked out, the divergence between certain theoretical issues of the older theory and experimental results.

Heisenberg and Jordan[20], with the help of the spinning electron were able to overcome long standing difficulties in the quantum treatment of the fine structure of spectra such as those of hydrogen and the alkalis, and of the anomalous Zeeman effect. The problem of the quantum treatment of impact processes was attacked by Born[21], with the help of the wave equation, and a solution found for the combination atom-electron, from which transition probabilities can be determined. Heisenberg dealt with the problem of resonance, applied to the spectra of atomic systems with two electrons, which led to a solution of another well-known difficulty, the ortho and para terms of the spectrum of neutral helium.[22] A further extension has been made to atoms with several electrons,[23] in order to elucidate the spectral terms of complex atoms; and the resonance principle has been studied in the theory of molecules and their band spectra. An immense field of application still remains to be explored, and we are far from any finality; such notable progress however, in the short space of three years justifies an optimistic outlook on the probable success of the unending efforts to evolve a completely generalised treatment of mechanics.

Errata.

P. 354, col. 1, l. 14; and p. 355, col. 2, last line—for 'discreet,' read 'discrete.'

P. 355, col. 1, l. 2—for e^2, read e^2 nmt

P. 355, col. 2, l. 29, and subsequently throughout the article—for 'δ,' read '∂,' and for 'δ²,' read '∂²' respectively.

P. 355, col. 2, l. 34—for 'E/p,' read $E/_h$.'

P. 356, col. 2, l. 13—the equation should read :—

$$\Delta^2\psi - \frac{4\pi i}{h}\dot{\psi} - \frac{8\pi^2 V}{h^2}\psi = 0.$$

P. 357, col. 1,—before the first line insert : 'system can be expressed in terms of a quan- '.

P. 357, foot of col. 1—in third equation of (2) : for r = s, read r = s.

In fourth equation of (2) : for $qp_r - pq_r$, read $q_r p_r - p_r q_r$

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^{19} *Proc. Roy. Soc.* A. CXVIII, p. 351, March, 1928.

^{20} *Zeits. f. Phys.*, XXXVII, p. 263, 1926.

^{21} *Zeits f. Phys.*, XXXVII, p. 863, 1926; XXXVIII, p. 803, 1926.

^{22} *Zeits. f. Phys.*, XXXVIII, p. 411, 1926; XXXIX, p. 499, 1926.

^{23} *Zeits. f. Phys.*, XLI, p. 239, 1927.

ADSORBENT MATERIALS OF USE IN CHEMICAL INDUSTRY.

By M. Schofield, M.A., B.Sc., A.I.C.

The progress of many chemical industries to-day is greatly influenced by the possibilities of producing the final substance in a high state of purity. It is not merely in the foodstuffs industries that the demand is evident for a finished product entirely free from objectionable odour or colour, but many manufacturers of other materials prefer to purchase a "clean" starting-material at a rather higher price for their particular needs.

The use of solid adsorbents for purification has now become extensive, and a wide variety of substances are marketed which are capable of extracting the undesirable matter from both liquids and gases. Adsorption is essentially a physical process, and it is the physical condition of the external surfaces and internal surfaces of the "pores" of the material which determines the effective action of the latter in a given case. The maximum effect can hardly be obtained in practice, however, for a finely ground material with high porosity often causes trouble in the subsequent filtration process, so that a compromise must be made between low division with low porosity, and fine division leading to the above difficulty.

Of the types of adsorbents which occur naturally, Fuller's earth holds first place, for it is mined, ground and dried without difficulty, and its use has been firmly established for a number of years. The material has proved of great value for refining oils and fats both for edible purposes and for soap manufacture, and in the refining of petroleum oils. The edible oils are usually purified by intimate mixing of adsorbent and oil, followed by filtration, although a second adsorbent (usually bone-charcoal) is often used in conjunction with the earth.

Petroleum oils are more conveniently clarified by the percolation method, in which the adsorbent is a powder coarse enough to allow the penetration of the liquid. Inferior deposits of natural earths have been made use of by treatment with mineral acids, live steam, etc., the final product often possessing an activity superior to the best natural earths.

A more modern type of inorganic adsorbent is the " gel " variety, in which a colloidal solid, with air as the disperse phase, is prepared from silica, alumina, or ferric oxide. The Silica Gel Corporation, Ltd., have marketed a product capable of drying large volumes of gases in a short time, an example being the drying of air for blast-furnace use at the Wishaw Works of the Glasgow Iron and Steel Co.

For the refining of organic products many varieties of carbon, both animal and vegetable, have been introduced and the development of this type of adsorbent has been most marked within recent years. More than a century ago " bone-char " was used for decolorising juices of beet, and large quantities are used in the sugar industry to-day, in spite of the competition offered by the manufacture of activated carbons. The sugar manufacturer is loth to use the new carbons, owing to the fact that revivification by washing, followed by " burning " in kilns, may be repeated with greater success in the case of bone-char, the higher mineral content being a possible explanation of the latter.

Charcoal obtained by the calcination of dried blood has also found uses, but future developments will probably be concerned with the new " activated " chars. These adsorbents are prepared by the carbonisation of many types of vegetable or carbonaceous materials, examples of which are wood, peat, lignite and nutshells. The work on the use of nutshell charcoal in gas-masks during the War has shown that this type of char is very active in removing traces of abnoxious gases from the air. Further uses of all varieties of active carbons include the removal of benzol from coal-gas, the purification of carbon dioxide from brewing vats, and the decolourisation of all kinds of solutions, syrups, etc.

The activation of these carbons is brought about by heating to 800° or above in revolving or stationary kilns, the material being subjected to hot flue gases, live steam, air, hydrochloric acid or chlorine, according to the particular patent used. Other methods consist in impregnating the char or material with mineral salts, zinc chloride for example, followed by kilning. The product needs careful washing in any case, and the market price is thus not low.

Future developments will depend on the possibility of producing highly active carbons at moderate cost, which will withstand many periods of regenerative treatment. The wood-distiller is able to furnish all grades of charcoal at a low price, but the high temperature, which the author has found to be essential for activation to the required degree, forbids the use by the wood-distiller of his own retorts for activating the char. With cheaper methods of activation, however, a product should be obtained at a price considerably less than that of bone-char, and with a much higher activity.

A CHEMICAL STUDY OF LOW TEMPERATURE TAR.

By Professor G. T. Morgan, F.R.S.

(Abstract of paper given at the Chemical Industry Conference, Monday, May 14, 1928. Chairman : Sir Hugo Hirst, Bart.)

The research under review has been in progress at the Chemical Laboratory, Teddington, since the beginning of 1926.

The tars and tar distillates, which have been supplied in large quantities by H.M. Fuel Research Station, are representative products of low temperature carbonisation derived from two typical coals.

Objective.—The object of the research was to increase our knowledge of the original constituents of low temperature tar. Since certain of these components undergo distinctive changes on heating, separation by solvents has been substituted for separation by distillation.

Solvent Separations. — In the solvent treatment the highest temperature employed did not exceed 120° C.

A tar treated in this way with such volatile solvents as ether, petroleum and acetone, left, after removing acidic and basic constituents and neutral oils, only 5.4 per cent. of amorphous solid, whereas when fractionated by distillation under the ordinary pressure, it gave 81 per cent. of pitch.

Identification of Chemical Constituents.—Among the solid aromatic hydrocarbons, two homologues of anthracene have been identified, namely β-methylanthracene and 2 : 6-dimethylanthracene.

A preliminary study has been made of the more volatile bases and the following have been identified :— aniline, a-picoline, 2 : 4-lutidine, *sym*-collidine, quinoline and quinaldine.

The phenolic constituents and their chloro-derivatives have been examined in regard to both chemical and bacteriological properties.

Summary of Results.—By solvent methods of separation the percentage yields of several potentially useful constituents of the tars have been notably increased.

The waxes obtainable by ordinary methods of freezing out represent about 1.7 per cent. of the tar. The yield of solid higher aromatic derivatives from undistilled tar is now 1.2 per ceut., and may be increased still further.

The bases of low temperature tar have been divided into two groups, volatile amines and resinamines.

A method has been evolved for separating by a simple economic process the true phenols from their phenate soluhle impurities. The phenols themselves have been separated into crystallisable phenols and amorphous resinols, both of which are likely to receive industrial application.

UNEXPLOITED BRANCHES OF INDUSTRY IN CZECHOSLOVAKIA.

Czechoslovakia, whose territories before the War pertained practically in their entirety to the Austro-Hungrian empire, far surpassed the other parts of that former customs entity in industrial development, and supplied to a very large extent the needs of that big area herself. Thus the Czechoslovak industries now produce on the whole a much larger output than is needed to meet the requirements of the domestic market, and have to export a big proportion of that output. In the world's markets international competition is encountered, and in order to maintain their position there the Czechoslovak industries are obliged to turn out wares that in quality and price can hold their own with the rest of the world.

Despite the well-developed level of Czechoslovak industry there are several branches which are either still in their initial stages or are still so undeveloped that the great bulk of those commodities with which they are concerned has to be imported from abroad. Thus there lies open both for home and foreign enterprise quite a considerable unexploited field in these branches.

The hulling and skinning of rice, for example, is practically unknown in Czechoslovakia, although the Republic imports cargo rice to the value of over 50 million crowns annually. Hulled and non-hulled rice pay the same customs duty (previously they were duty-free), but it is certain that a differentiation of duties could be secured if concerns were started within the country for the hulling and treatment of this important item of consumption. Again, the dyeing and printing of silk fabrics, especially artificial silk fabrics, is entirely undeveloped, and these articles, despite high customs duties, are mostly brought into the country from abroad. Dolls' heads of *papier mâché*, for which these exists a big demand, are imported to Czechoslovakia annually to the value of over 10 million crowns, although subject to heavy duty. They are not made at all in the Republic. Mouldings, beadings, etc., for furniture are made only in small workshops and in somewhat primitive fashion, but large quantities are imported. This, too, despite the fact that the furniture industry in Czechoslovakia is otherwise on a high level. The highly developed automobile industry, represented by seven large concerns, is compelled to import a whole series of half-finished material such as disk wheels, chains, ball-bearings, steps, etc., since there is not a single concern in the country that turns out these components. The Czechoslovak machinery branch, otherwise so well developed, also displays one or two big lacunae. Thus, for instance, machinery for the tanning, bootmaking and furrier trades is not turned out, nor are machines for chocolate making, nor the majority of machines used in printing, although the branches of industries requiring these types of machinery are exceedingly well developed. Another totally neglected branch of industry is the manufacture of watches, although there exists a considerable clockmaking trade. Not a single watch factory is to be found in all Czechoslovakia. Other branches of fine mechanics and optical instruments making are quite undeveloped, though there is not so much lack of the necessary skill on the part of workers as there is lack of capital. The output of optical glass (lenses, negative, etc.), pocket cameras, telescopes, binoculars and microscopes is only in its very beginnings. Again, there is not a single concern in Czechoslovakia turning out typewriters, the manufacture of which could be protected by an adequate duty. As typewriters are imported annually to the value of between 40 and 50

million crowns, their manufacture would assuredly result in good sales and satisfactory profits.

The list of branches of industrial output as yet inadequately developed in Czechoslovakia is not, of course, exhausted by the examples given above, nor is it to be expected that a comparatively small country can be entirely self-providing and independent of all import in all branches of industrial production. There is no doubt, however, that the lacunae here pointed out present very favourable opportunities for enterprise on the part of either home or foreign capital.—*Central European Observer.*

GENERAL NOTES.

DETECTION OF FIREDAMP BY FLAME SAFETY LAMPS.

The Secretary for Mines wishes to draw attention to Mines Department Safety Pamphlets 4A and 4B respecting the use of the Flame Safety Lamp for the purpose of detecting and measuring firedamp in mine air.

After referring briefly to the explosive nature of firedamp, each Pamphlet describes in simple language how to adjust the flame of a safety lamp when testing for gas, how to recognies the "fuel-cap," how to distinguish the latter from the "gas-cap," and how to estimate from the appearance of the "gas-cap" the percentage of firedamp present in the atmosphere.

Siuce, for a given percentage of firedamp, the appearance of the "gas-cap" is not precisely the same in all types of safety lamp, two editions of the Pamphlet have been published. The text is the same in both, but No. 4A contains illustrations of the "caps" seen for different percentages of firedamp in safety lamps burning a volatile spirit (such as naptha, benzene, etc.), with a round wick, while No. 4B contains illustrations of the "caps" seen in lamps burning mineral colza or paraffin (or mixtures of these two) with a flat wick, including combustion tube lamps.

The six illustrations in each Pamphlet are in colour, and are reproductions from actual photographs taken at the laboratories of the Safety in Mines Research Board. They show the gas cap within the framework of the lamp, as it appears in practice, and are ... realistic than the usual diagrams

It is hoped that these pamphlets will prove of great interest and practical value, not only to officials and firemen but also to workmen employed underground.

The pamphlets are published at 6d. each (by post 7½). and can be obtained from any bookseller or directly from H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2.

ONTARIO NICKEL-COPPER INDUSTRY.

The nickel-copper industry in Ontario experienced prosperity during the first quarter of 1928 as compared with the corresponding period last year. Ore smelted, matte made and matte refined and exported showed considerable gains above the 1927 period with correspondingly augmented recoveries in metal. An outstanding feature, however, was the gain in copper which rose from 5,722,874 pounds in 1927 to 8,418,418 pounds in 1928.

Developments mentioned a year ago at the Frood and Frood Extension mines of the International Nickel and the Mond Nickel companies respectively, have been actively carried on. The International completed their new shaft (28ft. 2 inches x 15ft. outside timbers) to 3,050 feet late in March, averaging 203 feet per month. Work is also under way on a ventilation shaft some 2,000 feet distant. The Mond shaft has reached a depth of about 3,000 feet.

DYESTUFFS (IMPORT REGULATION) ACT, 1920.

APPLICATIONS FOR LICENSES IN MAY, 1928.

The total number of applications received during the month was 588, of which 480 were from merchants or importers. To these should be added 7 cases outstanding on the 30 April, making a total for the month of 595. These were dealt with as follows :—

Granted—552 (of which 542 were dealt with within 7 days of receipt).

Referred to British Makers of similar products—31 (of which 25 were dealt with within 7 days of receipt).

Outstanding on 31st May—12.

Of the total of 595 applications received, 567 ,or 95 per cent. were dealt with within

GEOLOGICAL MAP OF EASTERN MANITOBA.

The Canadian Geological Survey has just issued a map of special interest to parties interested in mining in Eastern Manitoba.

The new map shows the geology of the mineralised area of eastern Manitoba, including Rice Lake, Long Lake, Beresford Lake and Gem Lake, and gives the names and locations of the claims. It is published on a scale of one mile to one inch, and copies may be had on application to the Director of the Geological Survey Branch at Ottawa, or to the Office of the High Commissioner for Canada, The Canadian Building, Trafalgar Square, London, S.W.1.

RUHR GAS.

To finance a widespread expansion of its gas distributing system, which it is planned to extend from the Ruhr as far north as Hamburg and the North Sea Coast, the Ruhr Gas Corporation, a company backed by 52 leading Ruhr coal and steel concerns, has just contracted a 25-year 6 per cent. $10,000,000 loan with an American banking consortium, headed by Dillon Read & Co., and Halsey Stuart & Co.

SCIENCE HELPING HOUSEWIVES.

The Home Life Exhibition at Croydon, which closed on June 9, was something of an innovation, since, unlike most local displays such as have recently been organised in connection with municipal health weeks, it has been accorded the backing of many undertakings of national repute.

The exhibits were classified, into sections which include furnishing and decoration, heating, lighting and cooking, labour-saving equipment, pure foods and toilet preparations, and number among them the products of a number of famous British firms. Among the largest exhibitors is the Government of New Zealand, which displayed many articles of produce, such as mutton, butter, honey, and fresh fruit. Another stand which attracted a good deal of attention was that of the United Dairies, with its well-arranged display of milk, butter, cheese and other produce. Here the visitors were able to slake their thirst with soda and pasteurised milk and other attractive hot-weather "quenchers."

Heating, cooking and lighting—one of the most important sections—were represented by the local gas company and the municipal electricity department, both of whom were showing a wide range of exhibits. The remarkable enterprise that has marked the progress of the gas interests of recent years is shown in the many new appliances on view at the company's stand. Prominent among these is a new type of elevated cooking range, finished in mottled enamel, which is capable of cooking all the items of a dinner simultaneously by means of an automatic device for regulating the oven temperature. The cooker also commends itself to feminine visitors by reason of its bright appearance, the raised position of the oven, the top of which is in line with the hotplate; and the large warming chamber with which it is equipped. In addition, there were art gas fires in copper and brass, circulators, coppers, geysers, hot towel rails, laundry irons, and a variety of lighting equipment on view.

CHEMICAL SUPPLIES WANTED FOR CANADA.

The Department of Overseas Trade has received a request from Canada for catalogues and price lists of United Kingdom manufacturers of chemical, physical and elementary science supplies.

Further particulars of this enquiry can be obtained by firms desirous of supplying goods of British manufacture on application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1., quoting reference B.X.4489.

LIEBIG'S EXTRACT OF MEAT CO., LIMITED.

An interim dividend in respect of the year ending 31 August, 1928, will become payable on and after the 2 July next, at the rate of seven shillings per share free of income tax, to the proprietors of Ordinary shares registered on the Company's books on 14 June. In respect of Coupon No. 90 of the Ordinary share warrants "to Bearer," such interim dividend will be payable on and after 2 July next, at the Company's bankers, Messrs. Glyn, Mills & Co., 67, Lombard St., E.C.2. Coupons must be left three clear days for examination before payment. Coupons may also be presented in Antwerp at the Banque Centrale Anversoise, for payment at the short exchange on London.

NETHERLANDS EAST INDIES TRADE REVIEW OF 1927.

The Department of Overseas Trade Reports.

For the Netherlands East Indies the year 1927 as one of steady commercial progress. At no time did the volume of trade offering or in sight reach the proportions of a trade boom, but the past twelve months have also been free of those patches of trade depression which were so noticeable in 1925 and in 1926. In all respects 1927 must be recorded as a most successful year for both import and export trade, while in agricultural pursuits much healthy progress has been made which will add to the general prosperity of the country.

It will be several months before returns showing th balance of trade during 1297 for the whole of the Netherlands East Indies become available, but preliminary figures for the import and export trade of Java issued by the Department of Agriculture, Industry and Commerce on February 10, 1928, show that the foreign trad e of the major island was greater than in 1926.

Exports.

The gross weight of exports from Java on private account (exclusive of ships' stores, parcel post, etc.), is officially stated to have been 3,28,8999 metric tons in 1927 as against 2,800,177 metric tons in 1926, the balance of trade in favour of exports being 1,880,640 tons or 558,566 tons greater than the previous year. The total value of exports form Java is given at 806,485,000 guilders as against 750,649,000 guilders in 1926, an increase of nearly 56 million guilders.

These are extremely healthy figures and reflect the general feeling of trade security.

THE FARADAY SOCIETY.

A General Discussion on " Homogeneous Catalysis " will be held in the Physical Chemistry Laboratory of the University of Cambridge, on Friday and Saturday, 28 and 29 September, 1928. Chairman: Professor C. H. Desch, D.Sc., F.R.S.

The subject for discussion will comprise the Catalysis of Homogeneous Reactions, such as Isomeric Change, Hydrolysis and Esterification, Association and Dissociation, Thermal Decomposition, Slow Oxidation, etc., under the following principal headings:

1. Uncatalysed Homogeneous Reactions and Negative Catalysis.
2. Intermediate Addition-Compounds in Homogeneous Catalysis.
3. Neutral Salt and Activity Effects in Homogeneous Catalysis.
4. Ionisation as a factor in Homogeneous Catalysis.

Heterogeneous catalysis, the radiation hypothesis, photochemistry and gaseous explosions, which have formed the subject of previous General Discussions, will be excluded from tbe programe.

A number of important foreign guests have been invited by the Society to take part in this Discussion.

Members and visitors will, by the kindness of the College authorities, be accommodated at Pembroke College during the period of tbe visit.

Further partieulars will be communicated shortly.

By order of the Council,

G. S. W. Marlow,
Secretary.

13, South Square,
Gray's Inn, W.C.2.

EXPLOSIVES IN MINES AND QUARRIES.

The Inspectore of Explosives in their latest report say that the total quantities of explosives used in mines and quarries during the years 1922 to 1926 are given in the following table :—

Explosives	1922. lbs.	1923. lbs.	1924. lbs.	1925. lbs.	1926. lbs.
Gunpowder ...	11,628,347	12,710,939	12,405,264	11,229,171	7,068,384
Permitted explosives	14,254,664	16,581,030	16,930,327	15,650,316	8,001,616
Other explosives	7,333,316	9,122,621	9,485,182	8,522,828	5,891,597
Total	33,216,327	38,414,590	38,820,773	35,402,315	20,961,607

The quantity of the permitted explosive Samsonite No. 3, responsible for the ignition in 1926, used in that year was 1.170,568 lbs.

The shot was thought to have been overcharged and to have lit gas which had formed in the space caused by a fall of roof in the waste.

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.

At the meeting held on Thursday, June 7, 1928, the following papers were read :—

The Emission of Secondary Electrons and the Excitation of Soft X-rays. By O. W. Richardson, F.R.S.

Recent experimental work by the author and others shows that these two groups of phenomena are closely interrelated. The existing data are analysed, and it appears that in order to harmonise the agreement between the soft X-ray and secondary electron discontinuities with the low soft X-ray and high secondary electron generation efficiencies, *it is necessary to postulate an abnormally high obsorption of the soft X-rays in the medium in which they originate.* The possibility of a similar misfit in connection with thermionic emission and chemical action is considered. In each case the radiation appears to behave as if it were absorbed about a million times faster near its point of origin than it would if it were separated out into a beam and its absorption coefficient measured elsewhere.

Electron Emission in Intense Electric Fields. By R. H. Fowler, F.R.S., and L. Nordheim.

The emission of electrons from a cold metal under a strong applied field is calculated exactly, using the new mechanics, Sommerfeld's theory of metals and the simplest form of boundary field, which is shown to be sufficiently representative for the problem in hand at all ordinary temperatures. The result is—

$$I = AF^2 e^{-\alpha\chi^{3/2}/F}$$

where I is the current, A a constant, α an absolute constant for all metals, χ the thermionic work function for the metal and F the strength of the applied field. The form of this formula is in excellent agreement with observation. The absolute value of α is such that when χ is between 4 and 5 volts the emission should begin to be appreciable when F is rather greater than 10^7 volts/cm. Emission is usually regarded as setting in at about 10^6 volts/cm., but certain experiments suggest that this is due to surface peaks and sensitive spots and that the true normal emission sets in at values in good accord with the theory.

The Excitation of Soft X-rays, II. By O. W. Richardson, F.R.S., and F. C. Chalklin.

Our former measurements on the critical potentials of iron have been extended. There is now a substantial agreement between different observers as to the complex phenomena displayed by this element. Rollefson's series is examined critically and found to be probably real. Similar series are suggested for cobalt and nickel and also combination series. The tungsten " spectrum " has been re-examined by deposition of tungsten on a carbon target. In this way it has been possible to show that the former " spectrum " was a mixture, the probable contaminant being nickel. The only discontinuities now remaining between 30 and 450 volts for tuugsteu are 36.8 (5), 40.3 (0), 44.9 (2), 70.8 (7), 108.2 (0)?. 245.2 (4), 263.7 (4), and 419.0 (2) volts. The values for Bohr's levels given by Nishina for tungsten are N 37·9, N_{VI} 39·3, O_{II} O_{III} 70·4 O_I 77·0, N_V 24 ·3, N_{IV} 254·8 and N_{III}445 volts

The following papers were read in title only :—

The Nodal Cubic Surfaces and the Surface from which they are Derived by Projection. By G. Timms. Communicated by H. F. Baker, F.R.S.

Cayley's classical treatment of the twenty-three types of cubic surface proceeds by the separate consideration of the several cases; it has been proved, but in a highly abstract manner, that every surface should be obtainable as the projection of a non-singular surface in higher space : the subject of this paper is the actual generation of all the various types of cubic surface by the projection of non-singular surfaces, *viz.*, the non-ruled surfaces of order *n* in space of *n* dimensions (here denoted by F^n).

It is shown that all F (with one exception), including those which themselves possess singularities, in particular the cubic surfaces, may be obtained by projecting the F^9; and that apart from *projections of* the Veronese surface, which are considered separately, every F^n is the projection of a suitable $F^{(n+1)}$ from a suitable point upon *it. In this way, commencing with the* F^9, all the F^n's are enumerated.

It follows incidentally that all the cubic surfaces could be obtained by projecting the intersection of a suitably special pair of quadrics lying in space of four dimensions.

On Quantitative Measurements in Frictional Electricity. By W. A. MACKY. Communicated by R. Whiddington, F.R.S.

An X-ray Investigation of the Structure of Some Naphthalene Derivatives. By J. M. ROBERTSON. Communicated by Sir William Bragg, F.R.S.

The X-ray investigation of naphthalene tetrachloride and 1.2.3.4.5.8.-hexachlornaphthalene.1.2.3.4.tetrahydride shows that in both cases the lattice is body-centred, and the space group probably C_s, involving polarity in the crystals. A method involving a statistical survey of the general plane is used to locate the reflection molecule and the groups of halogen atoms. These lie on a virtually different type of lattice and interleave the nearly flat carbon rings, the long axis of the molecule being approximately the *c*-axis of the crystal.

A Critical Absorption Photometer for the Study of the Compton Effect. By C. V. RAMAN, F.R.S., AND C. M. SOGANI.

The great difference in transmission through a filter on the two sides of the K-absorption edge forms the basis of a very simple and convenient method of studying the characteristics of the Compton effect. For this purpose the material of the target for the X-ray tube and the material of the filter placed in the path of the scattered X-rays are so chosen that the unmodified scattered ray lies on the short-wave side of the limit, while the modified ray scattered through a sufficiently large angle is on the long wave-length side of the limit. The increased transparency for the scattered radiation at such angles is readily shown by a photographic plate exposed to the scattered radiation behind the filter, a steel wedge placed side by side with the filter forming the standard of comparison. The point of equality of transmission between wedge and filter shifts farther and farther towards the thin edge of the wedge with increasing proportion of modified to unmodified scattering. The known features of the Compton effect are unambiguously indicated.

The Wave Equation of the Electron. By C. G. DARWIN, F.R.S.

In two papers Dirac has recently reconstructed the quantum mechanics of the electron, accommodating in a natural manner the properties associated with the "spinning electron." He works throughout with the calculus of *q*-numbers. The present work starts from his equation, but develops the same properties by the use of ordinary differential equations. There are four simultaneous partial differential equations of the first order, which in spite of their unsymmetrical appearance are invariant for Lorentz transformations. The formulæ for electric density and current density are developed from a variational principle. A comparison with previous theories shows that Schrödinger's equation is a first, and the equations of the present author a second, approximation to the exact equations. Freer motion is discussed, and the solution is found for the motion in a central field of force in terms of spherical harmonics. In the case of hydrogen the solution can be completed and leads exactly to Sommerfeld's original values for the levels. The combination rules and Zeeman effect are worked out.

The Molecular Displacements in Diffusing Gas-Mixtures. By S. CHAPMAN, F.R.S.

The paper is concerned with the distribution of the displacements, during any interval, of the molecules of a gas-mixture which at the commencement of the interval are situated in the same element of volume. It is pointed out that the displacement-distribution function found by Einstein for Brownian grains is applicable to a uniform gas-mixture, but that the constant D in his formula in general differs from the coefficient of diffusion for the mixture. The form of the function is found for a gas-mixture which is non-uniform in temperature and concentration, in the case where the concentration of one constituent is small.

A Series of Bessel Functions connected with the Lattice-Points of an n-dimensional Ellilpsoid. By J. R. WILTON. Communicated by G. H. Hardy, F.R.S.

It is known that the number of lattice-points in a many-midensional ellipsoid is expressible by a series of Bessel functions. The paper is concerned with the degree of appproximation given by a partial sum of this series, and with similar problems of a more general character.

On the Law of Large Numbers. By E. H. LINFOOT. Communicated by G. H. Hardy, F.R.S.

The paper discusses the following problem : Given an infinite sequence of trials, the probability of a success at the *i*th trial being p_i and the p_i being subject only to the (most lenient possible condition

$$\sum_{1}^{n} 2p_i q_i \to \infty \quad \text{as } n \to \infty, \quad (q_i = 1 - p_i)$$

how can we estimate the probable deviation $\omega(n)$ of the number m of successes actually obtained in the first n trials from the "normal number $\sum_1^n p_i$?

1. A thorem is proved about the behaviour of $P(m, n)$, the probability of m successes in the first n trials, when m and n are fixed and the p's vary so that $\sum_1^n p_i$, $\sum_1^n 2p_iq_i$ remain constant. It is shown that when $P(m, n)$ takes its greatest or least value, all the p_i which are not 0 or 1 have one of two fixed values.

With the help of this, results of the type

$$P(m \equiv m_0) = \frac{1}{\sqrt{\pi}} \int_{t_0}^{\infty} e^{-t^2} + \text{an error term}$$

are established, t_0 being subject to a condition of the form $t_0 = 0((\Sigma\ 2pq)^{\frac{1}{6}-\delta})$ and varying with n.

2. It is now proved that, $\epsilon > 0$ being arbitrarily chosen, we can make with probability 1 the double assertion :

$$(A) \begin{cases} |\mu(n)| < (1+\epsilon) & \sqrt{\Sigma 2pq \log \log \Sigma 2pq} \text{ for all large } n, \\ |\mu(n)| > (1-\epsilon) & \sqrt{\Sigma 2pq \log \log \Sigma 2pq} \text{ for an infinity of } n. \end{cases}$$

Thus $\sqrt{\Sigma 2pq \log \log \Sigma 2pq}$ is an "exact upper bound" to $|\mu(n)|$.

3. Finally a general theorem on results of this type is established, and (A) is slightly sharpened.

On Line-Integrals of the Diurnal Magnetic Variations. By A. T. PRICE AND S. CHAPMAN, F.R.S.

Line-integrals of the field of the diurnal magnetic variation are calculated, taken round the boundary of an area of 400,000 square kilometres in Northern Europe. Such calculations, here made apparently for the first time, bear on the question as to whether the field has a potential, or is partly due to daily variations of earth-air electric currente. The data used are the mean hourly inequalities of the two components of the horizontal magnetic force for the 20 international quiet days of the summer of 1924, derived from six observatories. The line-integrals do not vanish exactly, but their values are interpreted as due, not to earth-air currents, but to slight uncertainties in the data, owing to the observatories being too far apart round the boundary curve. If the non-zero line integrals were interpreted as indicating earth-air currents, the current-densities would be of the order 10^{-3} ampere/km^2, which is about one-tenth the order of the mean current densities inferred from line-integrals of the whole magnetic field; but the observed order of magnitude of the vertical electric currents in the atmosphere is 10^{-6} ampere/km^2.

THE CHEMICAL SOCIETY.

Thursday, June 7.

Studies of Valency. Part X. Electrometric Titration of Vernon's α- and β-dimethyltelluronium Bases. By F. L. GILBERT AND T. M. LOWRY.

The molecular conductivity of the α-base at 25° varies from 3 to 6, and that of the β-base from 31 to 36, in the range from $v = 32$ to 512. The molecular conductivities are increased to about 40 (at $v = 32$) by saturation with carbon dioxide, but are reduced to normal values by passing a current of purified air through the solutions.

Conductivity titrations of the bases show a break at the composition of the hydroxy-halide, but give no indication of the presence of the normal salt in the solutions.

Potentiometric titrations of the α-base with a glass electrode show the typical behaviour of a weak base, forming a nearly neutral hydroxy-salt, but they give no indication of the presence in solution of the oxyiodide and dioxyiodide which Vernon prepared in a crystalline form. The curves for the β-base, on the other hand, show an inflexion at about 50 per cent. neutralisation, corresponding with the formation of a basic salt, which has not been obtained in the free state.

Part XI. Molecular Conductivities and Extinction Coefficients of Derivatives of cyclotelluropentane. By F. L. GILBERT AND T. M. LOWRY.

Measurements have been made of the molecular conductivities and extinction coefficients of the cyclic tellurium compounds recently described by Morgan and Burgess. The tertiary salts behave as strong electrolytes like $TeMe_3I$, but the secondary salts lose one molecule of halogen by hydrolysis, giving rise to hydroxy-halides, like $TeMe_2I_2$. Observations of the conductivities of the base, and of the form of the curve obtained

from a potentiometric titration, together with the absorption spectrum of the iodide, show that the cyclic compounds resemble Vernon's α (or "*trans*") series of compounds rather than the isomeric β (or "*cis*") compounds.

The Action of Diazo-Salts on Aromatic Sulphonamides. Part II. The Mechanism of the Reaction and Constitution of the Diazo-Sulphonamides. By A. KEY AND P. K. DUTT.

The mechanism of the reaction, $R.SO_2NH_2 + R^1N_2X \longrightarrow R.SO_2NH.N : N.R^1 \longrightarrow R.SO_2H + R^1N_2$, which takes place in alkaline solution (*J. Chem. Soc.*, 1921, cxix, 2088) is discussed from the point of view of the electronic hypothesis. The action of an acid hydrolytie reagent on the diszosulphonamide leading to the formation of $R.SO_2NH_2$ and R^1OH, in relation to its constitution, and also the result of direct methylation of the substance leading to $R.SO_2N : N.NMeR^1$, are explained from the same point of view.

THE PHYSICAL SOCIETY.

A special general meeting of the Society was held on Friday, June 8, at the Imperial College of Science, Imperial Institute Road, South Kensington, London, S.W.7. The following papers were read :—

Contact Potential in the Dolezalek Electrometer Connected Idiostatically. By L. F. RICHARDSON, F.R.S., and STUDENTS of Westminster Training College.

Some Experiments on the Light-Sensitivity of Commercial Selenium Cells. By GEO. P. BARNARD, The National Physical Laboratory.

The Vapour Pressure of Water over Sulphuric Acid-Water Mixtures at 25° C. and its Measurement by an Improved Dew-point Apparatus. By J. R. I. HEPBURN, M.Sc., Ph.D., Northern Polytechnic.

A Demonstration of a Simple Practical Application of the Properties of Selenium Cells will be given by Mr. Geo. P. Barnard, the National Physical Laboratory.

On May 25, the following paper was read :

Some New Methods of Linking Mechanical and Electrical Vibrations. By W. H. ECCLES, D.Sc., F.R.S., AND MISS W. A. LEYSHON, Ph.D., was read by Miss Leyshon and illustrated by a demonstration.

ABSTRACT.

The paper describes a number of new methods whereby the frequency of an electric oscillatory circuit can be brought under the control of a tuning fork. The electrical circuit may include a crystal ontact, piezo-electric resonator, neon lamp or pointolite lamp. The latitude of working conditions is narrow, but the difference in natural frequency between the fork and the controlled circuit may be very considerable.

DISCUSSION.

Mr. T. G. Hodgkinson expressed great interest in the circuit arrangements which had been described. The mastery of the tuning fork over the natural frequency of the associated electric circuits must be attributed to the fact that the energy stored in the fork was very much greater than that stored electrically.

Dr. E. H. Rayner suggested that if a copper oxide rectifier were used instead of a crystal it might be possible to maintain electric oscillations of considerable power.

Dr. W. H. Eccles said that the most interesting feature of the circuits was one which it was difficult to demonstrate effectively to an audience—namely, the ability of the fork to impose its frequency on circuits of widely different natural frequency. The voltage-time curve in a neon lamp, arranged in association with a condenser to give intermittent illumination ,tapers off in the neighbourhood of the cut-off, and the voltage decrements due to the fork are consequently able to introduce considerable changes into the time of discharge of the condenser.

The meeting adjourned to the Royal School of Mines, where a Demonstration of " Some Effects of Alternating Magnetism with some Possible Application " was given by W. M. Mordey, M.I.E.E.

GEOLOGICAL SOCIETY.

Abstracts of papers read on Wednesday, June 13 :—

A Re-Excavated Cretaceous Valley on the Mongolian Border. By PROF. GEORGE BROWN BARBOUR, *M.A., Ph.D., F.R.S.E.*, F.G.S.

The paper traces the history of successive infillings and renewed erosion of a buried Cretaceous valley 600 feet deep discovered by the Author in the course of a survey of the algan district, on the Chinese-Mongolian border. The valley, originally cut in pre-

Cretaceous lavas, was completely filled by the Nantienmen Beds, levelled off by erosion, and entirely covered by a heavy capping of plateau-basalts.

During late Pliocene times a stream followed part of this old Mesozoic valley-axis before striking off at an angle. The valley-bottom was again filled up by wind-blown lœss in mid-Pleistocene times, again partly excavated in late Pleistocene, and once more filled with very late Pleistocene or early recent gravels. At present, the course is being opened for the fourth time. The Cretaceous-valley deposit (Nantienmen Beds) has been left clinging to the side-walls in many places, so that it has been possible to trace the old landscape and to compare this with the present topography.

The Volcanic Complex of Calton Hill (Derbyshire): a Petrological Study. By Sergei Ivanovich Tomkeieff, F.G.S.

The volcanic complex of Calton Hill shows two phases of vulcanicity :—

(i) Effusive phase represented by, besides the agglomerate and tuff of the old volcanic cone, a highly decomposed lava. Petrologically and chemically it is comparable withthe other contemporaneous Lower Carboniferous lavas of the district. The vesicles are filled up with a chlorite of delessite type.

(ii) Intrusive phase — represented by a fresh analcite-basalt, which has intruded into the old volcanic chimney and spread amœba-like in the volcanic cone, detaching large masses of vesicular lava. Besides abundant analcite, mostly in the form of spheroids, the basalt contains numerous inclusions of peridotite. These inclusions, apparently shattered fragments of a pre-existing rock, contain, besides the normal pyroxene, a definite hydrous augite.

On May 28, 1928, Prof. P. G. H. Boswell, D.Sc., F.G.S., delivered a lecture on the "Geological Features of the New Mersey Tunnel." He said that the recent "holing-through" of the highway-tunnel under the River Mersey, by which connection was established between Liverpool and Birkenhead(makes the present time appropriate for giving an account of the features of geological interest which were revealed. The tunnel will be the greatest subaqueous tunnel in existence. The predictions of T. Mellard Reade regarding the existence of a buried channel beneath the River Mersey, and of G. H. Morton of a sub-Mersey fault, were verified in the driving of the Mersey Railway-Tunnel some fifty years ago. Subsequent records by local geologists have ... ferences, and the geological observations made during the operations now proceeding are, in the main, in accord with expectation.

The subaqueous portion of the tunnel (44 feet in diameter) and the two Birkenhead approach-tunnels lie in the Middle Bunter Sandstane ("Pebble-Beds"), which dips eastwards at about 3° to5°. A fault-system, apparently of small aggregate throw, was met with at about 1828 to 1870 feet from the Liverpool shaft. The hade was eastwards, whereas in the case of the sub-river fault in the Mersey Railway-Tunnel it was westwards. On the Liverpool side, the presence of the "Castle Street Fault," which throws down the Upper (Soft) Bunter Sandstone on the east, was confirmed. At the Old Haymarket entrance another north-north-west and south-south-east fault throws eastwards, and brings Lower Keuper Sandstone into contact with Upper Bunter.

From observations in the area of the docks and the environs of Liverpool, and the numerous exploratory borings carried out in connection with the tunnel-works, it has been possible to construct exceptionally accurate profiles of the system of buried channels. They appear to be of subglacial origin, and do not deepen seawards; they are filled with gravel and sand, overlaid by boulder-clay. In place of the single channel found in the Mersey Railway excavations, two (or more) feeding-channels occur farther north.

Interesting, and at present unexplained, features have been observed in the levels of underground water. As would be expected, the fresh-water table rides on the back of the salt-water table in the neighbourhood of the Mersey estuary.

FORTHCOMING EVENTS.

THE ROYAL SOCIETY.

Thursday, June 21, at 4.30 p.m.—The following papers will be read :—

Sir Robert Robertson, F.R.S.—"Studies in the Infra-Red Region of the Spectrum."

Part I.—"Description of Prism Apparatus."

Part II. "Calibration of Prism Spectrometer; General Procedure; and Preparation of Pure Ammonia, Phosphine and Arsine Gases."

Part III.—"Infra-Red Spectra of Ammonia, Phosphine and Arsine."

Ammonia, Phosphine and Arsine."

With exhibition of apparatus.

C. V. Boys, F.R.S.: "Solid Dipleidoscope Prisms."

G. I. Taylor, F.R.S.: "The Forces on a Body Placed in a Curved or Converging Stream of Fluid."

S. S. Cook, F.R.S.: "Erosion by Water-Hammer."

Thursday, June 28.—The Bakerian Lecture will be delivered by Prof. J. C. McLennan, F.R.S., on "The Aurora and Its Spectrum."

ROYAL SOCIETY OF ARTS.

Wednesday, June 27, at 4 p.m.—Annual General Meeting.

THE PHYSICAL SOCIETY.

VISIT TO BRISTOL, SATURDAY, JULY 7, 1928.

The Council has accepted a kind invitation from Professor A. M. Tyndall to visit Bristol on Saturday, July 7, and to hold there a meeting in the new Henry Herbert Wills Physical Laboratory. The following programme has been provisionally arranged :—

Leave Paddington 8.55 a.m.; arrive Bristol 11.15 a.m. On arrival the party will drive to the Suspension Bridge, Durdham Downs, Shirehampton, and back through the Avon Gorge to the University. Cold lunch 12.45 p.m.

Meeting in the Physics Laboratory 2.30 p.m., at which Papers by workers in the Laboratory will be presented.

NOTICES OF BOOKS.

The Chemistry of Crude Drugs. An Elementary Text-Book for Students of Pharmacognosy. By EDMUND DRIVER, M.Sc., Ph.D., A.I.C., Lecturer in Chemistry, University College, Nottingham; AND GEORGE EDWARD TREASE, Ph.C., Lecturer in Pharmacognosy, University College, Nottingham. Pp. 160. Price 10s. 6d. net. London: Longmans, Green, and Company, Ltd., 39, Paternoster Row, E.C.4.

This is an exceedingly informative and useful work, dealing as it does with a large number of useful herbal and kindred subjects, such as the preparations from leaves, seeds, resins and the numerous extracts derived from them. The results of recent research has been carefully compiled in language that can be easily comprehended by the intelligent reader, whose knowledge of physical chemistry may be limited. Handy in size, without any redundant elaboration, and published at a modest price, the work merits a large sale.

Chemical Engineering and Chemical Catalogue Company.

We have received a copy of the fourth edition of this elaborate publication, which extends to over 380 4to pages. It is printed on good paper, profusely illustrated, and handsomely bound (Leonard Hill, Limited, 231-232, Strand, London, W.C.2.). It is a useful reference work, and of particular interest to all connected with the Chemical and Engineering Industries.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

15,561.—Dreyfus, H.—Manufacture of aliphatic compounds. May 26th.

15,025.—Hartmann, C.—Manufacture of organic salts of dyestuffs. May 22nd.

15,566.—Imperial Chemical Industries, Ltd.—Manufacture of anthraquinone derivatives, etc. May 26th.

15,029.—Eder, R.—Manufacture of polysulphides of aromatic carboxylic acids, etc. May 22nd.

Specifications Published.

266,007.—Monsanto Chemical Works.—Contact sulphuric acid process.

290,860.—I. G. Farbenindustrie Akt.-Ges.—Process for the recovery of sodium nitrate.

282,658.—Soc. L'Air Liquide, Soc. Anon. Pour L'Etude et L'Exploitation des Procédés G. Claude.—Processes for carrying out exothermic chemical reactions under pressure and at a high temperature.

286,290.—Compagnie Nationale de Matieres Colorantes et Manufactures de Produits Chimiques du Nord Réunies Etablissements Kuhlmann.—Manufacture of phosphorus, phosphoric acid, and hydrogen.

Abstract Published.

288,331.—Phosphates.—Soc. Anon. des Charbons Actifs E. Uubain, 134, Boulevard Haussmann, Paris.

Potassium-ammonium and other phosphates. — Potassium metaphosphate prepared as described in Specification 288,330 is hydrated to form di-potassium pyrophosphate or mono-potassium orthophosphate, and these substances are treated with nitrogen bases such as ammonia, urea, cyanamide, etc., to form complex compounds such as, for example, $PO(OK)(ONH_4)NH_2$, which are suitable for use as manures.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

PEDOIDS.

489,451.—Chemical substances prepared for use in medicine and pharmacy.—Boots Pure Drug Company, Ltd., 37, Station Street, Nottingham. May 30th.

DIAMALT.

487,573.—Chemical substances prepared for use in medicine and pharmacy.—H. A. & D. Taylor, Ltd., The Maltings, Sawbridgeworth, Hertfordshire. May 30th.

CODIKON.

490,173.—Chemical substances prepared for use in medicine and pharmacy.—Cody's Cash Chemists, Ltd., 126, Stephendale Rd., Fulham, London, S.W.6. May 30th.

GRODYL.

490,537.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—Bayer Products, Limited, 31 to 34, Basinghall Street, London, E.C.2. May 30th.

JUST PUBLISHED.

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CONTENTS. PAGE.

The Collinsics of Minerals 385
By Hawksworth Collins, B.A. (Camb.).
A Periodic Table of the Planets 387
By F. H. Loring.
Water Purification 389
By Sir Alexander Houston, K.B.E.
Thermal Expansion of Beryllium and Aluminum-Beryllium Alloys 389
By Peter Hidnert and W. T. Sweeney.
General Notes 390
Proceedings & Notices of Societies:—
The Royal Society 394
Sixth Congress of Czechoslovac Scientists, Physicians and Engineers 397
Correspondence: The Right Use of Coal 398
By W. Paling, M.P., and Tom Williams 398
New Patents 399
New Trade Marks 400

GENERAL INDEX TO THE "CHEMICAL NEWS"—VOLS. 1 TO 100.

This large volume contains a detailed Index to the first 100 volumes of the *Chemical News*, and will be found of great value to all interested in Chemical, Engineering, Electrical and General Scientific subjects. It has been compiled with great care, is handsomely bound in red cloth, and has been produced at great expenditure of time, labour and money. Carriage paid, Great Britain, 21/- net; Carriage paid to Foreign Countries and the Colonies, 28/- net.

THE COLLINSICS OF MINERALS. II.

By HAWKSWORTH COLLINS, B.A. (Camb.).

In this, the second paper on minerals, the theoretical results correspond very closely with the experimental data. In no case in this or in other papers do the results differ by as much as 1 per cent.

In presenting this matter to scientists it is necessary to be explicit, concise and exact all at the same time. The last two necessities are evidently complied with, but the first is the most difficult of the three to attain. Consequently another attempt is here made to explain the matter.

The word "Collinsics" stands for certain mathematical operations upon the experimental data of minerals, by means of which the exact relative volume of each atom in the substance is obtained, and also for certain operations upon the optical refractivity of each molecule, whereby the refractivity of each atom in the molecule is found. At the same time the word *stands* for the method of presenting the matter, which evidently cannot be improved upon for brevity, since every figure or letter in each collinsic is essential to the demonstration. Besides this the word represents something which has been accomplished after 28 years of study without the slightest encouragement from any leading scientist (except the late Sir William Crookes) or any learned Society. In addition to this each collinsic contains the proof of its truth within it.

The optical refractivity of an atom is the relative effect the atom has upon a ray of Na-light passing through it.

As Nitre (No. 17) is probably the best known of the twelve here published, and at the same time one of the simplest of minerals, it is taken as an example of all.

The relative volume 22.29 of K was discovered with those of many other elements on January 1, 1911, after several operations extending over ten years upon all known substances. About three scientists were interested in the discovery. The rest, including all the leading scientists, had no time to study the matter.

The volume 7.53 of oxygen was one of those discovered at the same time. The 3.8 of nitrogen was found about four years later. All three have frequently been demonstrated to be true in the *Chemical News* during the last ten years.

If the sum of these volumes (as given between the brackets in the second line of the collinsic) be divided into the molecular

weight, the result is 2.075, which lies between several experimental results of specific gravity, of which only the nearest is given.

If the same sum be multiplied by $\mu - 1$, where μ is the *refractive index of the* substance, the result is 16.259. In this case the theoretical refractive index is exactly the same as one given in a Smithsonian Publication (1.334).

The refractivity of K(22.29) has been found to be 7.49 in all minerals in which it occurs, whilst that of N(3.8) is 3.8 in all minerals and chemical substances, and that of 0(7.53) is always 1.654 in hundreds of substances. The sum of these refractivities (16.252) gives the refractivity of the whole substance, which corresponds to four figures with that obtained above.

Since similar remarks apply to all minerals, it is evident that each collinsic contains the exact truth plainly written upon it.

It is impossible for anyone to produce the collinsics of other minerals without a thorough study of the sixty papers in the *Chemical News* which led up to the present matter. The 24 collinsics which have now been published have been chosen because they do not give away the whole knowledge which is necessary for the production of the collinsics of other minerals, except perhaps three of four. But since these three or four are a few among hundreds, nobody would know which they are.

The refractivity of an atom is always placed directly under its relative volume.

TABLE II.

THE COLLINSICS OF TWELVE MINERALS.

	Theor. Column	Obs. Column
(13) Kaliophilite, $KAlSiO_4$ S.G.	**2.575**	2.493 - 2.602D
$K + Al + Si + O + O + O_2$		
$32.975 = 0.5374(22.29 + 9.05 + 13.02 + 7.53 + 4.45 + 2.51_2)$		
R.I.	**1.5374**	1.537 S
$32.978 = 7.49 + 7.865 + 11.53 + 1.654 + 1.747 + 1.346_2$		
(14) Sodalite $Na_3Al_3Si_3O_{12}.NaCl$	**2.21**	2.14 - 2.3 D
$Na_4 + Al_3 + Si_3 + O_{12} + Cl$		
$104.32 = 0.4761(11.865_4 + 9.05_3 + 13.02_3 + 7.53_{12} + 15.085)$	**1.4761**	1.4827 D
$104.31 = 3.865_4 + 7.865_3 + 11.53_3 + 1.654_{12} + 10.82$		
(15) Grossularite, $Ca_3 + Al_2 + Si_2 + O_{12}$	**3.438**	3.47 - 3.286 D
$98.031 = 0.7489(14.54_3 + 9.05_2 + 13.02_3 + 2.51_{12}$	**1.7489**	1.7468 - 1.76 D
$98.032 = 10.52_3 + 7.865_2 + 11.53_3 + 1.346_{12}$		
	3.355	3.353 D
(16) Zoisite, $HCa_2Al_3Si_3O_{13}$		3.361 D
$H + Ca_2 + Al_3 + Si_2 + Si + O_{13}$		
$95.833 = 0.7083(5.76 + 14.54_2 + 9.05_3 + 13.83_2 + 13.02 + 2.51_{13})$	**1.7083**	1.706 S
$95.836 = 2.613 + 10.52_2 + 7.865_3 + 9.78_2 + 11.53 + 1..346_{13}$		
(17) Nitre $K + N + O_3$	**2.075**	2.074 15°.5 Holk
$16.259 = 0.334(22.29 + 3.8 + 7.53_3)$	**1.334**	1.334 S
$16.252 = 7.49 + 3.8 + 1.654_3$		
(18) Pyrope $Mg_3 + Al_2 + Si_3 + O_{12}$	**3.66**	3.66 D
$81.567 = 0.7428(7.51_3 + 9.05_2 + 13.02_3 + 2.51_{12})$	**1.7428**	1.745 S
$81.565 = 5.031_3 + 7.865_2 + 11.53_3 + 1.346_{12}$		
(19) Enstatie, $MgSiO_3$	**3.131**	3.1 - 3.3 D
$Mg + Si + O_2 + O$		
$21.40 = 0.67(7.51 + 13.02 + 4.45_2 + 2.51)$	**1.67**	1.669 - 1.674 D
$21.401 = 5.031 + 11.53 + 1.747_2 + 1.346$		

	Column Theor.	Column Obs.	
(20) Forsterite, Mg_2SiO_4	**3.33**	3.33	D
$Mg_2 + Si + O_2 + O_2$			
$\mathbf{27.778 = 0.662(7.51_2 + 13.02 + 4.45_2 + 2.51_2)}$	**1.662**	1.659	D
$\mathbf{27.778 = 5.021_2 + 11.53 + 1.747_2 + 1.346_2}$		1.670	D
(21) Monticellite, $CaMgSiO_4$	**3.184**	3.03-3.25	D
$Ca + Mg + Si + O_2 + O_2$			
$\mathbf{33.264 = 0.679(14.54 + 7.51 + 13.02 + 4.45_2 + 2.51_2)}$	**1.679**	1.67	M
$\mathbf{33.267 = 10.52 + 5.031 + 11.53 + 1.747_2 + 1.346_2}$			
(22) Kalinite, $KAl(SO_4)_2.12H_2O$	**1.75**	1.75	D
$K + Al + S_2 + O_4 + O_4 +$			
$\mathbf{117.715 = 0.4345(22.29 + 9.05 + 15.53_2 + 7.53_4 + 2.51_4 + 14.03_{12}}$			
	1.4345	1.43	S
		1.458	S
$\mathbf{117.719 = 7.49 + 7.865 + 5.75_2 + 1.654_4 + 1.346_4 + 6.572_{12}}$			
(23) Talc, $H_2Mg_3Si_4O_{12}$	**2.71**	2.7-2.8	D
$H_2 + Mg_3 + Si_4 + O_4 + O_8$			
$\mathbf{76.82 = 0.55041(5.76_2 + 7.51_3 + 13.83_4 + 7.53_4 + 2.51_8)}$	**1.55041**	1.539	S
$\mathbf{76.823 = 2.613_2 + 5.031_3 + 9.78_4 + 1.654_4 + 1.346_8}$		1.589	S
(24) Sodium Nitrate	**2.222**	2.2256	Kars
$Na + N + O_3$		2.200	Kopp
$\mathbf{12.624 = 0.33(11.865 + 3.8 + 7.53_3)}$	**1.33**	1.33608	D
$\mathbf{12.627 = 3.865 + 3.8 + 1.654_3}$			

The thick type denotes the discovery; the ordinary type gives the experimental data (of other scientists); which helped to lead to the discovery.

The last paper on nitrogen is being held back for the present to make room for these collinsics.

D stands for Dana; S for Smithsonian Publication; and M for Miers.

ERRATA IN PAPER I OF THIS SERIES.

In Corundum 19.768 should stand for 19.68 and 1.346_3 for 1.346.

The twelfth mineral is Leucite, not Leutic.

A PERIODIC TABLE OF THE PLANETS.

By F. H. LORING.

In this Journal of April 13 and May 4, 1928, reference was made to the classification of the planets in tabular form, somewhat after the manner of the co-ordination of the elements by means of so-called periodic tables, as a result of the B-number scheme of the writer and other considerations, particularly that the planets were formed in a manner developed by J. H. Jeans, who says :— " Two stars may run into one another, although this is very rare. A more common occurrence is for two stars to escape running into one another by a narrow shave. When this happens, huge tides are raised on the two stars involved, and these may take the form of long streamers of gas, which ultimately condense into ' drops ' just as did the gas in the outlying regions of the spiral nebulæ. It seems reasonably certain that the planets were formed in this way."—*Nature*, March 24, 1928; see also *Nature*, March 1, 1924.

The idea here is that the planets were drawn out from the sun in the above manner at opposite diameters so that they (*i.e.*, the material) would break up or condense as beads on a two-arm spiral line. Of course, the *line* is imaginary, just as the *curve* in a graph connecting points is imaginary from the point of view of the phenomenon described. A passing star is supposed to have caused this disruption of matter as already stated, but there is no need to go into the details of such an event here.

This would, however, involve B numbers (corresponding with the planets as previously indicated) falling into two groups arranged side by side, as it would be expected that whatever happened on one side of the sun would happen on the other—at least to a considerable extent, as the two

stars would have swung round each other. That this was the case there can be little doubt as the accompanying table shows parallelism throughout. The diameters (mean) are in miles, and the *masses* are relative to that of the earth taken as unity.

It will be seen that Venus and the earth are in well-recognised parallel relationship, as are Neptune and Uranus. Jupiter and Saturn are the two large planets in the respective series, and Mars parallels well with the original hypothetical *single* planet as discussed in the previous papers (*loc. cit.*).

The existence of planets beyond Neptune has been considered by W. H. Pickering. See *Nature*, Aug. 28, 1919; and April 14, 1928, p. 598. Russell, Dugan and Stewart in their "Astronomy," 1926, vol. I, p. 404, say: "Uranus has been observed over nearly $2\frac{1}{2}$ revolutions, and there appear to be small unexplained irregularities in its motion, not exceeding 5″, but probably real. From these Gaillot, Lowell and others have been led to suspect the existence of a planet distant from the sun about $1\frac{1}{2}$ times the distance of Neptune. Lowell finds that in this case there are two possible positions for the unknown body, almost 180° apart in longitude showing that the solution of the problem is not always unique, as it was in the case of the discovery of Neptune. The mass of the hypothetical planet comes out less than half that of Neptune; but, even on the most unfavourable assumptions regarding its density and albedo, it ought to be about the twelfth magnitude, and a conspicuous object on long-exposure photographs, so that, if it really exists, it is rather surprising that it has escaped discovery so long. Gaillot suspects another larger planet, rather more than twice as far from the sun as Neptune. One thing, at least, is definitely proved by these investigations. If there were a planet as large as Neptune within twice the distance of Uranus, or one as large as Jupiter $2\frac{1}{2}$ times the distance of Neptune, it would produce much larger disturbances in the motion of Uranus than have been observed; and hence no unknown planets exist unless they are considerably smaller."

There is one feature in these relations that requires clearing up, and that is the fact that the equation for the B numbers (*loc. cit.*) ends at the value 119, unless the equation can be extended. Can it be that there were further explosions in the more remote planets and satellites? For example, was Neptune thrown out from Jupiter; and, very much in the same way, but not perhaps quite the same thing, did Saturn and Uranus part company, so to speak? In the case of the distant satellites having B numbers of 411 and 805, or thereabouts, which are smaller bodies than those nearer their primaries, were they the result of a later explosion? At such remote regions there might be comparatively large separations as gravity would be weak there. Judging from the tentative data given in "Astronomy," vol. I (see appendix), these outer bodies would be very small, and some of them are subject to very great perturbations.

As a branch thought in connection with these matters it is of interest to note that the passing star (see above) may have had drawn out a set of attendant planets with satellites almost precisely like those of the solar system. The writer has never come across a discussion of this possibility, but to discover such a now distant double would be far beyond the powers of astronomy to-day.

This article should be read in conjunction with the two previous articles referred to at the outset, as certain features previously gone into should be taken into account.

B No.	Planet.	Diam.	Mass.
—	—	—	—
7	Venus ...	7700	0.81
13	Mars ...	4215	0.108
45	Jupiter ...	86720	316.94
411 {	Neptune...	31000	17.6
	—	—	—

B No.	Planet.	Diam.	Mass.
3	Mercury	3100	0.042
9	Earth ...	7917	1.000
21	Asteroids	(small)	(small)
119 {	Saturn ...	71500	94.9
	Uranus...	31700	14.66
805	—	—	—

LORD MELCHETT.

The King has approved of the following title being taken by the Rt. Hon. Sir Alfred Mond, Bart.:—

Baron Melchett of Landford in the County of Southampton.

IMPERIAL CHEMICAL INDUSTRIES.

At a meeting of the Board of Imperial Chemical Industries Limited, held on Thursday, June 14, The Right Honourable the Lord Weir, P.C., was elected a Director.

WATER PURIFICATION

By Sir Alexander Houston, K.B.E.

(Abstract of Paper read before the Chemical Industrial Conference, Monday, May 14. Chairman : The Rt. Hon. Lord Desborough, G.C.V.O.)

This question has been dealt with primarily with regard to the Metropolitan Water Supply. Interesting features are that the area covered by the Board's sand filtration system is nearly equivalent to the area covered by Greenwich Park; the water in store would suffice to give the whole world one gallon of water per head per day for ten days; the Board's mains placed end to end would more than stretch to America; London water supply is the greatest in the world.

The sources of the supply, in the order of quantity are the Thames, the Lee, the New River, and the Deep Wells.

The improved purity of water is not only due to better service, but also to storage, which purifies the water by sedimentation, equalisation, and de-vitalisation. The Queen Mary Reservoir at Littleton holds 6,750 million gallons and looks like an island sea. At the Chelsea reservoirs the beneficial effect of storage is specially pronounced. Not only is the reduction in bacteria remarkably high, but chemical results are also very marked.

Many rare birds visit the reservoirs, and large fish have been caught in them. Gulls are a source of embarrassment.

One disadvantage of storage is that it leads to the development of algal and other growths. These, harmless in themselves, may interfere with filtration, and give the water an unpleasant taste. Of these, Asterionella has a blocking effect on filters; Oscillaria causes the water to look as though it had been fouled with green paint; Dinobryon is supposed to give the water an objectionable taste. There are also Fragilaria which interferes with filtration, and Tabellaria, giving an unpleasant flavour which can be removed with permanganate in doses of 2 to 4 lbs. per million gallons. All these growths may be inhibited or destroyed by means of copper sulphate in doses of about 0.25 part per million parts.

Most of the water is filtered through fine sand at the slow rate of less than 2 gallons per sq. ft. per hour. The first filter bed was constructed at the Chelsea Works in 1829, and the pattern set by London has been copied all over the world, doubtless greatly diminishing water-borne disease. At the new works at Walton there is a double system of filtration, first through rapid filters at the rate of 120-gallons per sq. ft. per hour, then through slow sand secondary filters at 5-gallons per sq. ft. per hour. The rapid filters remove most of the grosser suspended matter, including algal and other growths, and thus prolong the life of the secondary filters. Phenomenal quantities of water can be filtered by this double process between successive cleanings of the secondary beds, the average being actually 445 million gallons per acre. The chemical and bacteriological results are not quite so good as those obtained by the older method, but chlorination is employed as a final safeguard.

Chlorination was first used at Lincoln in 1905. The following methods have been tried successfully. Chlorine alone; ammonia and then chlorine to the whole volume of water being treated; ammonia and chlorine added to the minor volume of water, then adding the mixture to the rest of the water to be treated; chlorine and permanganate, the latter being added before, during or after the chlorine treatment; ammonia then chlorine then permanganate; super-chlorination and then de-chlorination.

In the excess lime method, the principle is to add a little more lime than is required to combine with the bicarbonates, thus killing the microbes. The water is next carbonated then filtered at a very rapid rate. At Langford the results showed that the ammoniacal nitrogen and albuminoid matter reduced 68 per cent., the colour 75 per cent., the hardness 59 per cent., and over 99 per cent. of the bacteria were removed or destroyed. Where it is considered essential to soften as well as purify an impure hard water ,the excess lime method has perhaps no equal.

THERMAL EXPANSION OF BERYLLIUM AND ALUMINUM- BERYLLIUM ALLOYS.

By Peter Hidnert and W. T. Sweeney.
(U.S.A. Bureau of Standards.)

Abstract.

The investigation described in this paper was undertaken because no data on the thermal expansion of beryllium of any of its alloys were available. The paper gives results on the linear themal expansion of beryllium (98.9 per cent.) and five aluminium-beryllium alloys containing various percentages of beryllium (4 to 33 per cent.) Expansion determinations were made over

various temperature ranges, between - 120 and + 700° C. on a sample of beryllium, and between room temperature and 500° C. on the aluminium-beryllium, alloys. The expansion curves of beryllium and aluminium-beryllium alloys are shown and discussed

The average coefficient of expansion of beryllium is 12.3 × 10—[6] per degree centigrade between 20 and 100° C. Beryllium expands considerably less than the other elements of subgroup IIB (magnesium, zinc, cadmium, and mercury).

The coefficients of expansion of the aluminum-beryllium alloys decrease with increase in the beryllium content. On a second heating the coefficients are generally larger than the corresponding values obtained in the first heating. The relations between the coefficients of expansion and the chemical composition were compared with the equilibrium diagram obtained by Oesterheld, and were found to be in agreement with the theory.

In view of the fact that there was no available information on the thermal expansion of beryllium of any of its alloys, an investigation was recently undertaken to supply data on this metal and some of its alloys.

This paper gives the results of the investigation on the linear thermal expansion of beryllium and five aluminium-beryllium alloys containing various percentages of berylliunf (between 4 and 33 per cent.). Expansion determinations were made over various temperature ranges between - 120 + 700° C. on a sample of beryllium and between room temperature and 500° C. on the aluminium-beryllium alloys. Five tests were made on the specimen of beryllium and two tests on each of the aluminium-beryllium alloys.

The authors wish to express there appreciation for the co-operation of the Beryllium Corporation of America, Cleveland, Ohio. This company furnished the samples of beryllium and aluminum-beryllium alloys, and information about the preparation. Acknowledgment is due to H. W. Bearce, W. Souder, and H. W. Gillett, Bureau of Stanrards, for valuable suggestions.

II. Materials Investigated.

On sample of cast beryllium and five samples of cast aluminum-beryllium alloys (4 to 33 per cent. beryllium) were investigated. Each sample was approximately 300 mm. in length and 10mm. in diameter. casting of beryllium was furnished by the manufacturer:

In melting and casting beryllium our practice has been first to prepare a flux composed of about 10 per cent. barium fluoride and 90 per cent. barium chloride. This flux after fusion and cooling is ground to a fine powder. The buttons of massive beryllium are placed in a graphite crucible and a small amount of this powdered flux sprinkled on the surface. The crucible is then covered with just the ordinary graphite cover and heated to about 1,350 or 1,400° C. in a gas furnace. About 5 or 10 minutes before pouring it is advisable to remove the cover and dotate the crucible in order to bring all the particles of metal together in one fluid mass. It is then superheated for about 10 minutes longer and rapidly cast. We might add that in the melting of small amounts, such as 10 to 25 g., some losses are sustained, but in handling larger amounts we have been able to geat practically 100 per cent, recovery n this manner.

The Beryllium Corporation of America states that virgin aluminum and beryllium containing about 99 per cent. beryllium were used in the preparation of the aluminum-beryllium alloys. Iron was the chief impurity in beryllium. The cast alloys were prepared by heating the two metals (aluminum and beryllium) to about 1,100 to 1,200° C. with a small amount of the fluride-chloride flux mentioned in the preceding paragraph.

GENERAL NOTES.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH.

Physical and Chemical Survey of the National Coal Resources.

In connection with the Physical and Chemical Survey of the National Coal Researches which is one of the important aspects of the Fuel Research work of the Department of Scientific and Industrial Research, the Department has recently appointed a Committee to deal with the South Wales Coalfield, with the following constitution:—

Representing the Monmouthshire and South Wales Coal Owners' Association:—Mr. A. G. Brown, Mr. D. F. Davies, Mr. R. Gibb (Junr.), Mr. W. D. Woolley.

Representing the South Wales Institute of Engineers:—Mr. W. O'Connor.

Representing the Geological Survey of

Great Britain :—Dr. T. Robertson.

Representing the Department of Scientific and Industrial Research :—Dr. C. H. Lander (*ex officio*), (Director of Fuel Research); Dr. F. S. Sinnatt (*ex officio*) (Superintendent of the Physical and Chemical Survey of the National Coal Resources).

Committees are already actively at work in the following areas—Durham and Northumberland, Lancashire and Cheshire, South Yorkshire, Nottinghamshire and Derbyshire, North Staffordshire and in in Scotland.

The object of the Survey is to investigate the characteristics of the various coal seams in the country with a view to their utilisation to the best advantage. Local laboratories are established in each area for the examination of samples and, when necessary, large scale investigations are carried out at H.M. Fuel Research Station or elsewhere.

The work of each committee is to advise as to which seams should be investigated, to recommend what large scale work should be undertaken and to bring to the Department's notice any problems of particular local interest which may require investigation.

OUR COAL EXPORT FIGURES.

Futility of Amateur Remedies.

The Trade and Navigation returns issued on June 13 by the Board of Trade show very clearly where is the real seat of the trouble in the British coal industry.

For the five months to May 31 our coal exports are down by nearly 1,800,000 tons as compared with 1927. The only consolation is that, with the exception of April which was affected by Easter, the figures for each month of this year show a small but steady increase on those of the month before. During May we exported 375,000 tons more than in March.

A closer examination reveals what has happened. The three principal Scandinavian countries—where Polish competition is most acute—have between them imported 951,000 tons less than in 1927.

Italy, where we are in competition with reparation coal from Germany, has taken 400,000 tons less. France, Belgium and the Netherlands between them have taken 582,000 tons less, and Spain, in spite of all the protestation about no restriction upon British coal, has imported 856,000 tons less of it. Of the principal European countries only Germany shows any considerable increase—516,000 tons.

These figures surely provide their own commentary upon proposals either for a return to the 7-hour day or for nationalisation—both of which would admittedly increase the cost of production of British coal. They indicate, also, only too clearly what happens when goods produced under widely different standards of work and life compete in the world market.

WHOLESALE PRICES IN MAY.

Board of Trade Index Number.

Wholesale prices as measured at the Board of Trade were, on the average, 0.4 per cent. higher in May than in April, the index numbers for the two months being 86.4 and 86.1 respectively (1924 = 100). Comparing May with April, meat and fish rose and miscellaneous foods fell by 3.5 per cent.; cereals rose by 1.6 per cent. For industrial materials a rise of 0.4 per cent. is also recorded, cotton materials rising by 2.4 per cent., and the "other metals and minerals" and "miscellaneous" industrial groups rising by 0.3 and 0.8 per cent. respectively. These rises were offset by falls of 0.7 and of 0.4 per cent., in the "iron and steel" and "other textiles" groups.

CANADA'S GROWING CHEMICAL INDUSTRIES.

According to a preliminary report issued by the Dominion Bureau of Statistics at Ottawa, the 1927 production value of Canadian-made chemical and allied products reached a total of $126,668,773, thus exceeding the record figure of $122,589,526 attained in 1926, and those of all previous years since the close of the Great War.

Capital and Production.

Employing on the average 14,405 people and paying $18,585,987 in salaries and wages, the 560 plants in the industry represented a capital investment in money, lands and plants amounting to $134,550,473.

Production.

Raw materials at a delivered cost of $63,512,487 were converted into products of the industry worth $126,668,773, so that the value added in manufacturing amounted to $63,156,286. This was a new record for this item, marking an advance of more than $691,842 over the previous high mark established in 1926. The chemical industry is still centred in Ontario and Quebec. In 1927 there were 297 plants located in Ontario having an aggregate production worth $73,959,168, or $2,600,000 more than in the preceding year, while in Quebec there

were 171 plants with an output value of $39,307,208 or about a million dollars more than in 1926. British Columbia, Manitoba, Nova Scotia, New Brunswick, Alberta and Saskatchewan followed in the order named.

Nearly all groups report higher production. With only one exception, the industries in the chemical and allied products group reported higher total output values in 1927 than in 1926. Production from the acids, alkalies, salts and compressed gases industry which is the most important, amounted to $30,679,260, an increase of $446,938 over 1926; paints, pigments and varnishes gained $557,450 to $25,360,687; soaps, washing compounds and toilet preparations advanced by $538,649 to $19,611,177; medicinal and pharmaceutical preparations rose by $677,150 to $16,059,625; the miscellaneous chemical industry increased slightly to a total of $311,851,164; coal tar and its products advanced $666,182 to $3,754,325; inks, dyes and colours, $324,330 to $3,144,275; fertilisers $179,600 to $1,629,189; explosives, ammunition, fireworks and matches, $765,859 to $12,921,079. The one exception to the striking list of advances was the decline in the value of production of wood distillates and extracts from $1,734,993 in 1926 to $1,587,704 in 1927.

Imports and Exports.

Imports into Canada of chemicals and allied products in 1927 were valued at $33,313,500, a gain of two million dollars. Purchases from the United States amounted to $22,022,946, from the United Kingdom $4,347,931, and from other countries, $6,942,623.

Exports from Canada of chemicals and allied products during 1927 had a value of $17,854,915 comprising exports to the United States valued at $8,834,844, to the United Kingdom $3,926,063 and $1,676,417 to Mexico. Other countries to which Canada exported chemical products in quantity were :— Japan $595,500; Portuguese Africa $481,012; Newfoundland $477,751; Cuba $260,774; Australia $195,368; Belgium $135,442; New Zealand $121,400. Canada also exported chemical products in a less amount to a score of other countries.

CAUSES OF FAILURE OF WROUGHT IRON CHAINS.

Many cases have been encountered in practice in which wrought iron chains have failed under circumstances where such factors as gross overloading or defective material could be excluded. A report recently issued describes an investigation which has been conducted at the National Physical Laboratory with the object of determining the conditions under which wrought iron chains become liable to sudden failure in a manner usually associated with brittle materials. The desirability of periodical annealing as a restorative treatment and the merits of normalising have also been investigated.

DISCOVERY OF POTASH SALTS IN NEW BRUNSWICK, CANADA.

By L. H. Cole,
Mines Branch, Department of Mines, Ottawa.

The search for potash salts was greatly stimulated throughout the Empire during the war when supplies from German sources were unobtainable, and since the war the search has been continued in the hope that deposits of economic importance would be located at some time within the confines of the Empire. Developments in Canada have been closely watched by the Dominion Department of Mines and every possibility has been thoroughly investigated.

Recently at Gautreau, New Brunswick, about eight miles south-east of Moncton, a well was drilled in search of oil and gas by the D'Arcy Exploration Company on behalf of the New Brunswick Gas and Oilfields, Ltd. This well was sunk to a depth of 1,878 feet and penetrated a bed of rocksalt 485 feet thick, the top of the salt bed being at a depth of 1,295 feet from the surface. As the drilling was done by a standard churn drill no cores were recovered, but chip samples were taken for every five feet in depth. No special precautions are known to have been taken to prevent soluble salts from being washed out of these cuttings.

FIFTY-SECOND REPORT OF H.M. INSPECTORS OF EXPLOSIVES.

(H.M. Stationery Office, 9d. net.)

The Report says (*inter alia*) :—

Inspection Work.

The number of visits we have been able to pay to factories, magazines, stores and registered premises is very substantially in excess of the number paid in 1926 when the shortage in the inspectorate and still more the coal stoppage caused a drop in the inspection work. Every factory on our books has been visited once, the great majority twice and several three times. It is again satisfactory to be able to report that no serious irregularity came to our notice

during the manufacture of explosives except in connection with an accident at the Firework Factory at Ossett, referred to later, where a breach of the licence occurred under circumstances which are explained. The majority of magazines have been inspected more than once. Two magazines were not visited, one because it became extinct before inspection and the other because it is in disuse, and being situated on Raasay Island, access is so difficult and expensive that the expenditure of time and money would not seem to be justified.

MANUFACTURE AND STORAGE.

Factories.—The total number of factories is now 98, three having become extinct. Of the 98 factories, 22 are under Continuing Certificate and the remainder under licence. Fifty-seven Amending Licences were issued. There were also 19 toy firework factories, and four small firework factories. The latter are licensed by the Local Authorities and both classes are supervised by them. Three of these were visited by us.

Magazines.—There are now 379 magazines, 17 having become extinct and three new licences having been issued. Fifteen Amending Licences were also issued.

Stores and Registered Premises.—The number of these given in the quinquennial return in 1925 was 3,619 stores and 44,760 registered premises. We visited 87 stores and 468 registered premises. As usual various irregularities mostly of a minor description were found, but in two cases proceedings resulted.

Accidents.—There have been 56 accidents in manufacture, three of which resulted in the deaths of six persons. Only 14 persons were injured. There were no accidents in connection with magazines, stores, or registered premises. All the accidents are dealt with in the Accident Section.

Illegal Manufacture.—A case came to our notice where a manufacturer had added an ingredient to an explosive without having submitted the question to us. A sample was subsequently submitted for examination and the ingredient was allowed.

Defective Explosive.—Samples of Blasting Gelatine and Gelatine Dynamite taken at one of our inspections of a magazine in Cornwall were found to be exuding nitroglycerine. 165 lbs. of explosive were taken out to sea and thrown overboard in deep water. Two cases of ammonium nitrate explosive were found to be wet at a magazine in Durham and the explosive was destroyed at our request.

Unlawful Entry.—Some boys found the door of an explosives store at a colliery broken open, and stole some gunpowder. One of the boys threw some of the gunpower into a fire and the flash set fire to the clothing of two of them, who were burned severely and one died from the effects. Two other boys received less serious burns.

Proceedings and Seizures.—On the 2 April one of us, on inspecting Magazine No. 687 at Llanelly, occupied by Messrs. Samuel Bevan, Son and Roberts, Ltd., found an excess of 8,550 lbs. of explosives. Proceedings were instituted against the firm, but the charge was dismissed on payment of costs. In five other cases explosives in magazines were placed under seizure for smaller excesses or other irregularities, but were released upon explanations being made. In one case one of us placed some explosives in registered premises under seizure on account of an excess, and proceedings were taken by the Local Authority, and the occupier was convicted and finer. In another case the Local Authority caused explosives in a store to be placed under seizure after an inspection by one of us. Proceedings were taken and the occupiers were convicted and fined.

PACKING AND CONVEYANCE.

Special Packing Authorities.—Twenty-four packing authorities were granted during the year. Ten of these were granted to enable manufacturers to execute foreign orders.

Illegal Marking.—Some cases of gunpowder imported from abroad were found incorrectly marked in a magazine. The attention of the agents was called to the matter.

Accidents.—A small quantity (30 lbs.) of gunpowder was being conveyed in a lorry in three tins and some grains of the powder escaped. On arrival at a sand pit, the driver was examining his oil pump and found the tap blocked. He took out a match to push it up the tap, and before doing so struck the match. The head appears to have flown off and ignited the spilled powder, with the result that the powder in the tins ignited and the men were burned. The matter was taken up with the Local Authority concerned. (Accident No. 275.)

Byelaws.—Byelaws have been approved by the Minister of Transport for the Shropshire and Montgomeryshire Light Railway and for the Kent and East Sussex Light Railway.

IMPORTATION.

Licences. — Eighty-four importation licences were granted during the year.

Explosives Imported.—

	lbs.
Aluminium Torches	107,105
Amorces	13,204
Cheesa Sticks	47
Clermonite Powder No. 2	10,000
Cooppal's Excelsior Powder	5,000
Cooppal's Powder	3,000
Cordeau Bickford	39,945
Detonators	107,584½
Emerald Powder	5,000
Flashlight Ignition Caps	10
Manufactured Fireworks	2,327
Peacock's Eyes	110
P.R. Gelignite	4,000
Scintillettes	872
Walsrode Smokeless Powder	10,000
Five samples for Chemical Examination	3½
Total	308,208

It should be noted that no importation licence is required in case of gunpowder, and consequently it does not appear in the table above.

Irregular Importations. — There were twelve instances of explosives being imported without licence. In eight cases licences were granted to cover the importations, and the consignments were released in due course. In the remaining four cases the goods were either destroyed or returned to the port of origin. In two of the cases the goods consisted of miniature pin fire cartridges for watch chain pistols. There are not allowed on account of the liability to explode " en masse," and the consignments were destroyed.

In Appendix B will be found a list of Ports in Great Britain for which Importation Licences are authorised to be granted and which have been approved by the Customs for the sampling of explosives.

(*To be continued.*)

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.

June 7, 1928.

The Influences of Vortices upon the Resistance Experienced by Solids Moving Through a Liquid. By W. G. BICKLEY. Communicated by G. I. Taylor, F.R.S.

Two cases of two-dimensional streaming [illegible] the fluid pressures calculated. In the first where there are two symmetrically disposed vortices, the resultant is a force in the line of motion. In the second, with one vortex and circulation, the force is inclined to the direction of motion. " Life " and " drag " are calculated, and the life-drag curves show a resemblance to those found experimentally for the Flettner rotor.

The Effect of Temperature on the Viscosity of Neon. By R. S. EDWARDS. Communicated by H. L. Callendar, F.R.S.

This paper is an extension of previous work, which described a new method for the accurate determination of the variation of the viscosity of air with temperature, and applies a modified form of the apparatus to the case of a gas of which only a limited quantity is available. The gas experimented upon was neon, purified by a simple method of fractional distillation over charcoal surrounded by liquid air. Measurements were taken over the range -78.4° to 444.5° C., and their representation by the theoretical formulæ of Sutherland and Lennard-Jones discussed.

The Distribution of Stress Round a Circular Hole in a Plate. By W. G. BICKLEY. Communicated by E. G. Coker, F.R.S.

The paper considers the distribution of generalised plane stress in a uniform, infinite, elastic plate due to an arbitrary distribution of traction round the boundary of a circular hole. The cyclic terms in the stress-function, in which only the elastic constants occur, are first examined, and several simple distributions obtained with a view to showing the smallness of the effects of Poisson's ratio. The differential equation of the stress-function is then solved for the most general distribution of boundary traction. The stresses are shown to be expressible in terms of two pairs of conjugate functions, and these in turn are expressible as definite integrals involving the boundary tractions. A physical interpretation of these integrals in terms of " stress sources " is obtained. In Part II the results are applied to the examination of some experimental results, and the stresses calculated from those observed near the hole fall away with distance very much as do the observed ones.

On Phenomena Occurring in the Condensation of Atomic Streams on Surfaces. By J. D. COCKCROFT. Communicated by Sir Ernest Rutherford, P.R.S.

The conditions under which atomic

different surfaces have been investigated. As shown originally by Wood, condensation into a homogeneous deposit does not occur unless the surface temperature is below a certain critical value, and it is shown here that this critical value is a function of stream density, the stream density required varying by a factor of 10^4 as the surface temperature varies over a range from $-80°$ to $-150°$ C. The magnitude of the variation allows the surface adsorption forces to be found, and it appears that when no precautions are taken to outgas the surface, the forces are identical for different metallic surfaces and glass. Experiments are described in which the effect of gas is eliminated, and it is shown that the surface forces are increased. The experiments are shown to confirm the theory of formation of surface films put forward by Frenkel, and in particular experiments are described which show the motion of the adsorbed atoms on the surface. The application of the work to experiments using molecular streams is pointed out.

The Dependence of the Photographic Action of β-Rays on their Velocity. By C. D. ELLIS AND G. H. ASTON. Communicated by Sir Ernest Rutherford, P.R.S.

In order to make use of photographic methods for determining the relative intensities of β-ray lines, it is necessary to know how the photographic action depends on the velocity of the particles. Measurements have been made of the relative photographic activity of β-rays in the range of speeds $H\rho$ 2,000—$H\rho$ 8,000 by direct comparison of photographs of the continuous spectrum of radium B and C with Gurney's electrical measurements. The results are given in tabular form and in a diagram, and show, for example, that electrons of speed $H\rho$ 5,000 have only one-half the photographic effect of electrons of speed $H\rho$ 2,000.

The Study of the Specific Resistance of Bismuth Crystals, its Change in Strong Magnetic Fields, and Some Allied Problems. Part I. Growth of Crystal Rods with Definite Orientation of Crystal Planes, and Specific Resistance of the Crystals. By P. KAPITZA. Communicated by Sir Ernest Rutherford, P.R.S.

It has been shown that during the growth of bismuth crystals, a small strain set up has great influence on orientation of the trigonal axis of the crystal lattice, and has the effect of changing the perfect cleavage plane from one of the pseudo-octahedral planes to one of the three remaining planes of the same pseudo-octahedron according to char-

In order to obtain crystal rods with perfect cleavage plane orientated in any desired direction relative to axis of rod, no strain must be set up during crystallisation. A method is described by which this is effected. Further, it has been shown that during the growth of the crystals, cracks and imperfections are developed in the lattice, which account for the variation of specific resistance observed in previous researches. It has been shown that in the case of a perfect crystal the specific resistance along the trigonal axis is $1.38\ 10^{-4} \pm 1$ per cent., and perpendicular to the axis $1.07\ 10^{-4} \pm 1$ per cent. at temp. 16°.

It is found that the cracks are produced during cooling at a temperature very close to that at which bismuth solidifies, while their character depends chiefly upon temperature gradient at point where it crystallises. A perfect bismuth crystal has no well-defined cleavage plane at room temperature, and is very flexible.

An explanatory hypothesis put forward is that there are two crystalline bismuth modifications; one at present unknown but probably cubic, and transferred to the ordinary rhombohedral modification at temperature slightly below melting point, accompanied by a change of shape, which accounts for the occurrence of the crack.

The Study of the Specific Resistance of Bismuth Crystals, its Change in Strong Magnetic Fields, and Some Allied Problems. Part II.—Methods for Observation of Change of Resistance in Strong Fields. By P. KAPITZA. Communicated by Sir Ernest Rutherford, P.R.S.

A description is given of a method for measuring change of resistance of a conductor when placed in a magnetic field which exists for 1/100 second. The study of the change of resistance is made possible by the fact that larger current densities are permissible in the conductor, during this short interval, without heating the conductor, and no special sensitive apparatus is required. The measurements can be made with an oscillograph.

A special switch is described which permits the current to be sent for a very short time through the conductor under examination while the magnetic field is in existence. The make-and-break of this switch may be adjusted relatively to the current wave through the coil producing the magnetic field, with an accuracy of about 0.0002 sec.

Experimental arrangements are described which permit the study of the change of the resistance of bismuth crystals in a magnetic

Elimination of errors, due to induction effects and heating of crystal during measurement, is discussed.

The Study of the Specific Resistance of Bismuth Crystals, its Change in Strong Magnetic Fields, and Some Allied Problems. Part III. Change of Resistance of Bismuth and Time-lag in Magnetic Fields. By P. Kapitza. Communicated by Sir Ernest Rutherford, P.R.S.

A method is described of eliminating time-lag in measuring the change of of resistance in a magnetic field. Experimental results at 290, 196 and 91° abs. are given for change of resistance when current is perpendicular to field, for different orientations of crystal axis relative to the field. It is shown that impurities and imperfections in the crystal lattice greatly influence the change of resistance, especially with low temperatures and strong fields. Change of resistance of a perfect crystal in magnetic fields is discussed. It is shown that in weak fields change of resistance follows a square law, and in strong fields a linear law. The linear law is practically independent of orientation of crystal relative to field.

The case of current parallel to lines of force of field was also investigated for different orientations of crystal axis. A " saturation effect " was found. The change of resistance is very small and strongly affected by imperfection of crystal lattice.

Experiments are described for making perfect crystals by straight deposition of bismuth vapour *in vacuo* on cooled plates. Experiments for obtaining single crystals failed, but by studying change of resistance of deposits in a strong field, certain phenomena previously observed in thin layers were explained.

Rough investigation was made of the E.M.F. occurring in bismuth in a field when a current is passing and accounting for the time-lag. This reaches very large values in strong fields. The relation of this E.M.F. to perfection of crystal and its orientation relative to field is discussed, and also the relation of the experimental results to existing theory of metallic conductivity.

The following papers were read in title on June 21 :—

" The Polarisation of Radio Waves," by J. Hollingsworth. Communicated by Sir Joseph Petavel, F.R.S.

" The Spark-Spectrum of Copper," by A. C. Menzies. Communicated by R. Whiddington, F.R.S.

" The Structure of Cyanite," by W. H. Taylor and W. W. Jackson. Communicated by W. L. Bragg, F.R.S.

" A New Interference Method of Measuring the Surface Area of Film Catalysts. Part I. Theory," by F. H. Constable. Communicated by T. M. Lowry, F.R.S.

" A New Interference Method of Measuring the Surface Area of Film Catalysts. Part II. Nickel," by F. H. Constable. Communicated by T. M. Lowry, F.R.S.

" An Experimental Study of the Flow of Water in Pipes of Rectangular Section," by S. J. Davies and C. N. White. Communicated by E. V. Appleton, F.R.S.

" The Photoelectric Properties of Some Metals in the Soft X-ray Region," by L. P. Davies. Communicated by O. W. Richardson, F.R.S.

" Condensation Phenomena at Different Temperatures," by C. F. Powell. Communicated by C. T. R. Wilson, F.R.S.

" The Existence of Volatile Intermetallic Compounds. The Band Spectra of the Alkali Metals and of their Alloys with each Other," by J. M. Walter and S. Barratt. Communicated by T. R. Merton, F.R.S.

" The Theory of Rayleigh's Principle as Applied to Continuous Systems," by G. Temple. Communicated by S. Chapman, F.R.S.

" The Selective Photo-Chemical Action of Polarised Light, Part II.", by E. S. Semmens. Communicated by E. C. C. Baly, F.R.S.

" The Absorption Spectra of Solutions of Cobalt Chloride, Cobalt Bromide and Cobalt Iodide in Concentrated Hydrochloric, Hydrobromic and Hydriodic Acids," by W. R. Brode and R. A. Morton. Communicated by E. C. C. Baly, F.R.S.

" The Mechanism of Chemical Change. I. Promotion and Arrest of the Mutarotation of Tetra-Acetylglucose in Ethyl Acetate," by T. M. Lowry, F.R.S., and G. G. Owen.

" The Homogeneous Reaction Between Hydrogen and Oxygen," by C. H. Gibson and C. N. Hinshelwood. Communicated by Sir Harold Hartley, F.R.S.

" The Stark Efffect of the Fine Structure of Hydrogen," by R. Schlapp. Communicated by C. G. Darwin, F.R.S.

" The Characteristics of a Karman Vortex Street in a Channel of Finite Breadth," by H. Glauert. Communicated by G. I. Taylor, F.R.S.

" Gaseous Combustion at High Pressures, X.," by D. M. Newitt. Communicated by W. A. Bone, F.R.S.

"On Series in the Spark Spectra of Germanium," by K. R. Rao and A. L. Narayan. Communicated by Lord Rayleigh, F.R.S.

"The Structure of Thin Films. Part XI," by N. K. Adam. Communicated by Sir William Hardy, F.R.S.

"A Revision of the Theory of Transfer Resistance," by E. Newbery. Communicated by Sir Ernest Rutherford, P.R.S.

"Metal Overvoltage Measurements with the Cathode Ray Oscillograph," by E. Newbery. Communicated by Sir Ernest Rutherford, P.R.S.

"Observations on the Band Spectrum of Mercury," by Lord Rayleigh, F.R.S.

"Photoelectric Effect of Soft X-rays," by G. B. Bandopadhyaya. Communicated by O. W. Richardson, F.R.S.

"On the Chemical Reactions of Carbon Monoxide and Hydrogen after Collision with Electrons," by A. Caress and E. K. Rideal. Communicated by T. M. Lowry, F.R.S.

"The Electromotive Behaviour of Thin Films. Part I. Hydrogen," by F. P. Bowden and E. K. Rideal. Communicated by T. M. Lowry, F.R.S.

"The Electromotive Behaviour of Thin Films. Part II. The Areas of Catalytically Active Surfaces," by F. P. Bowden and E. K. Rideal. Communicated by T. M. Lowry, F.R.S.

"The Detonation Wave in Gaseous Mixtures and the Pre-detonation Period," by G. P. Thomson. Communicated by Sir Joseph Thomson, F.R.S.

"The Diffraction of Cathode Rays by Thins Films of Copper, Silver and Tin," by R. Ironside. Communicated by Sir Joseph Thomson, F.R.S.

"The Diffraction of Cathode Rays by Thin Celluloid Films," by A. Reid. Communicated by Sir Joseph Thomson, F.R.S.

"The Zeeman Effect in the Band Spectrum of Helium," by W. E. Curtis and W. Jevons. Communicated by H. C. Plummer, F.R.S.

"The Scattering of Cathode Rays," by B. F. J. Schonland. Communicated by Sir Ernest Rutherford, P.R.S.

"Note on Total Reflexion of Electric Waves at the Interface between Two Media," by H. M. Macdonald, F.R.S.

"The Energy of a Body Moving in an Infinite Fluid, with an Application to Airships," by G. I. Taylor, F.R.S.

SIXTH CONGRESS OF CZECHOSLOVAK SCIENTISTS, PHYSICIANS AND ENGINEERS.

The sixth Congress of Czechoslovak Scientists, Physicians and Engineers has just been held in Prague, under the patronage of President T. G. Masaryk. Altogether 110 Chemical papers were read, and some were of outstanding merit.

Prof. G. Urbain (France), Prof. W. P. Jorissen (Holland), and Prof. T. Milobedski (Poland), represented the Chemical Societies of their respective countries.

Prof. Urbain delivered an address "Sur les Complexes parfaits et imparfaits."

Prof. Jorissen described some of his researches upon Reaction Regions; Prof. Milobedski and J. Walczynska read a paper on the synthesis of hypophosphoric acid; and another Polish chemist, Prof. St. Tolloczko, gave a well-received paper upon a "Kinetic Formula for the Velocity of Adsorption."

Among the Czech contributions were :—

"The Action of Thiosulphate on Cupric Salts," by Prof. J. Hanuš and Dr. V. Hovorka.

"Antimony Yellow," by Prof. J. Milbauer.

"The Oxidation of Alkali Sulphites to Dithionates and the Density of Anhydrous Sodium Thiosulphate by Molybdic Acid as a Catalyst in the Reduction of Nitric Acid by Ferrous Chloride (with Dr. V. Netuka), by Prof. R. Hac.

"Low Temperature Evaporation," by V. Staněk.

"Revision of the Atomic Weight of Arsenic, and Perselinic Acid," by Prof. J. Křepelka.

"Solubility of Silver in Water," by Prof. Křepelka and Dr. F. Toul.

"The Occurrence of Mn Homologues in Mn Ores," by Dr. V. Dolejšek, Dr. B. Gosman, Prof. J. Heyrovsky, and Prof. A. Šimek.

"Alkaline Peraluminates," by J. Prásek.

"The Electrochemical Preparation of Berborates," by Profs. Matejka and Pospišil.

"The Influence of Organic Compounds on the Precipitation of $Al(OH)_3$" by Prof. O. Quadrat and J. Korecky.

"Normal and Acid Lithium Aluminates," by Prof. Heyrovsky and D. Proeiv.

"Complex Scandium Compounds," by [illegible]

"Thermal Dissociation of Nickel Hexammine Chloride," by Dr. V. Volenek.

"*The Precipitation of Zinc Ferricyanide*," by F. Cuta.

"Permanganate Titrations of Thallous Salts," by Drs. A. Jilek and J. Lukas.

"Electro-analysis of Cu in Presence of Meta-stannic Acid," by Prof. J. Šveda and N. Masalsky.

"Rapid Electro-analysis of Tin," by Dr. Šveda and R. Uzel.

"Fluxes from the Basic Martin Process," by Prof. Quadrat and Dr. V. Kraftener.

"Corrosion in Zinc-Tin Alloys," by Prof. R. Vondraček and A. Bockarev.

"Estimation of Traces of Iodides and Bromides with Chlorides in Natural Waters," by Dr. O. *Tomiček and* A. Jansky.

"Determination of Inorganis Matter in Coke,' 'by K. Hradsky.

"Photometric Measurement of Crystallised Sugar," by A. Růžička.

"Photometric Investigations of Solid Phase Formation. I. Crystallisation from Aqueous Solutions; II. Coagulation of Colloids," by Dr. K. Šandera.

"*Inversion of Saccharose* by Weak Acids," by Dr. V. Zafouk.

"On Adsorption and Swelliug," by Prof. V. Kubelka.

"The Behaviour of Fused Tellurium Dioxide on Noble Metals," by Prof. A. Šimek.

"The Hydration of Ions," by Prof. J. Baborovsky.

"Influence of Temperature on the Electrolysis with the Dropping Mercury Cathode," by Dr. V. Nejedly.

"Reduction of Sulphurous Acid at the Dropping Mercury Cathode," by Dr. B. Gosman.

"Deposition of Radium and other Alkaline Earth Metals at the Dropping Mercury Cathode," by Dr. S. Berezicky and Prof. Heyrovsky.

Other researches with the Dropping Mercury Cathode were described by Prof. Heyrovsky. These had been carried out with the help of various collaborators.

The following papers relate to Organic Chemistry:—

"Sandaracopimaric Acid," By Dr. F. Balaš and J. Brzak.

"Peligot's Saccharine: A New Method for Isolating Choline and its Separation

"Nitration Products of Methyl Naphthalene," by Prof. V. Vesely, H. Olejniček, E. Rein and A. Vojtech.

"Magnesium Derivatives of p-dibromobenzene," by R. Lukeč and V. Prelog.

"Slow Combustion of Hydrocarbons," by S. Landa.

Prof. Hanuš and his collaborators have studied a number of oximes and other nitrocompounds.

Prof. E. Votoček and his research workers continue investigations upon the sugars and their acids and osazones.

Prof. Cyril Krauz and his assistants presented important papers upon poly-nitro derivatives, smokeless powders and on drying oils.

There were also a number of papers on Applied Chemistry, *e.g.*:—

"On the Solubility of CO_2 in Sugar Sap and its Fixation by Amino Acids," by V. Majer.

"The Significance of the Baking Test in Bread and Pastry," by F. Hruška.

"Lubricating Oils," by F. Heyd.

"Humic Acids in Lignite," by B. G. Šimek.

"Manufacture of Vegetable Charcoal," by J. Milbauer.

"*Polarimetric* Estimation of Starch in Potatoes," by F. Herles.

"Dimorphism in Yeasts," by J. Šatava.

"Researches on Mortars, Cements and Ceramic Products," by O. Kallauner.

CORRESPONDENCE.

THE RIGHT USE OF COAL.

The blame for the continued loss in the coal industry, as revealed in the latest returns, cannot be placed at the doors of the miners, for lower wages have actually been accompanied by increased output. The owners have had their solution, and it has solved nothing.

The recommendations of the Samuel Commission for the better utilisation of our coal resources have been generally ignored, and the investigation of new methods is being left to chemists and engineers outside the mining industry. Low temperature carbonisation, with its prospects of a smokeless domestic fuel and valuable oil and petroleum by-products, and the pulverised fuel system,

boilers, and even more particularly to marine firing, are not receiving the support of the mine owners, who seem to be unable to understand that their problem is more than waiting for improved prices for raw coal, produced on low wages.

We have recently inspected a pulverised fuel plant, using one of the new short flame burners, and we have difficulty in understanding why its possibilities have not evoked the active interest of the collieries. Using smalls and even low-grade fuels for which there is no other demand, it opens up a new market, and, with its application to marine firing, it promises to win back for coal a sphere that is otherwise finally lost to oil.

Despite the immense promise of pulverised fuel and the low temperature carbonisation process, the coal owners potter around blindfold, muttering about wages and markets. Unfortunately, the official world is no more helpful. The Admiralty is content to declare that it is watching pulverised fuel progress with interest, but it declines to undertake or facilitate experiments or trials. It depends on imported oil for naval fnel and adds to its responsibilities the task of bringing oil to this country for the use of merchant ships in time of war, yet with this double burden on its shoulders. it merely looks benevolently at the private engineer and his pulverised fuel plans.

The Fuel Research Board is certainly more active, but its operations are limited because of insufficient funds. Its usefulness could be increased by widening the scope of its own experimental work and in testing the work of others and, by its reports and certificates, helping the public to discover which of the various systems and inventions hold the promise of success. By such work the Board would secure an effective concentration of public opinion, calculated to drive the mine owners to action.

Yours faithfully,

(Sgd.) W. Paling, M.P.
Tom Williams, M.P.

FORTHCOMING EVENTS.

THE ROYAL SOCIETY.

Burlington House, London.

Thursday, June 28. — The Bakerian Lecture on "The Aurora and its Spectrum," will be delivered by Prof. J. C. McLennon, F.R.S.

The following papers will be read in title only on June 28 :—

"Photographic Study of Detonation in Solid Explosives." By E. Jones. Communicated by J. F. Thorpe, F.R.S.

"On the Potential of the Electromagnetic Phenomena in a Gravitational Field." By E. T. Whittaker, F.R.S.

"The Kinetics of the Decomposition of Calcium Carbonate Hexahydrate." By B. Topley and J. Hume. Communicated by Sir Harold Hartley, F.R.S.

"On the Kinetic Method in the New Statistics and its Application in the Electron Theory of Conductivity. By L. W. Nordheim. Communicated by R. H. Fowler, F.R.S.

"Observations on the Height of the Ozone in the Upper Atmosphere." By F. W. P. Götz and G. M. B. Dobson, F.R.S.

"An Improved Method of Ultra-Violet Polarimetry. Anomalous Rotatory Dispersion of Sodium Tartrate." By T. M. Lowry, F.R.S., and M. S. Vernon.

SOCIETY OF GLASS TECHNOLOGY.

A Meeting of the Society will be held on Thursday, June 28, 1928, at the Applied Science Department of the University, St. George's Square, Sheffield, at 11.15 a.m. A list of other functions to be held during the same day is given below.

9.45 a.m.—Meeting of Council.

11.15 a.m.—Ordinary General Meeting.

1 p.m.—Lunch at the King's Head Hotel.

2.30 p.m.—Reception of the American visitors at the Department of Glass Technology, Darnall Road.

4.15 p.m.—Tea at the Department by invitation of Prof. Turner.

7 for 7.15 p.m.—Complimentary Dinner to the members of the American Ceramic Society, at the Royal Victoria Hotel, Sheffield.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

16,077.—Du Pont de Nemours & Co., E. L. — Preparation of chemical substances. June 1st.

15,868, 15,869.—Hull, P. H.—Effecting chemical reactions in gases by electrical discharges. May 31st.

15,926.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of phosphoric acid. May 31st.

15,889.—Davidson, A.—Manufacture of sulphonated aminoanthraquinone. May 30th.

15,690.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of 7 acylamino-1 : 4 naphto-quinones. May 29th.

Specifications Published.

262,101.—I. G. Farbenindustrie Akt.-Ges. —Manufacture and production of monocarboxylic acids.

268,826.—Soc. of Chemical Industry in Basle.—Manufacture of dyestuffs.

291,249.—Schuster, R.—Manufacture of a chromic acid in a solid form soluble in water.

289,087.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of derivatives of 2-oxynaphthalene-3- carboxylic acid amide.

283,119.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of methylene chloride.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

ANTOXYLIN.

487,087.—Chemical substances prepared for use in medicine and pharmacy.—Oxo, Limited, Thames House, Queen Street Place, London, E.C.4. May 23rd.

EPHEDROL.

488,491.—Chemical substances prepared for use in medicine and pharmacy.—Bayer Products, Limited, 31-34 Basinghall Street, London, E.C.2. May 23rd.

PHENYLDENT.

489,831.—Chemical substances prepared for use in medicine and pharmacy.—Thomas John Vernon Parry, 349, Buxton Road, Stockport. May 23rd.

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CONTENTS. PAGE.

Note on Solid Solution and Compound Formation ... 401
By Alexander Lehrman (College of New York).
The Pollution of Tidal and Non-Tidal Rivers ... 403
By J. H. Coste, F.I.C., F.Inst.P.
Overpotential in Metallic Cathodes ... 404
By Julius Grant, M.Sc., A.I.C.
General Notes ... 405
Livingstone College ... 408
Proceedings & Notices of Societies :—
The Royal Society ... 409
The Optical Society ... 410
Mineralogical Society ... 411
Royal Agricultural Society ... 412
Report of H.M. Inspectors of Mines... 412
Notices of Books ... 413
Forthcoming Events ... 415
New Patents ... 415
New Trade Marks ... 416

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NOTE ON SOLID SOLUTION AND COMPOUND FORMATION.

By ALEXANDER LEHRMAN
(College of the City of New York).

There are numerous descriptions in the literature of compounds and of solid solutions formed in binary and ternary systems. The authors of some of these articles, for example, Hill and Miller (*J. A. C. S.*, 1927, XLIX, 669), speak of 'pure' compounds in which there is no solid solution, and of solid solutions as if these were types which can be distinguished from each other without difficulty.

Let us consider a binary system. The melting point-composition curve that denotes compound formation is usually of the type represented in Fig 1. The composition

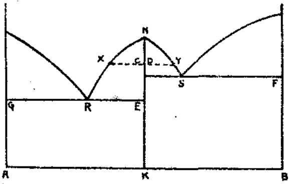

Fig. 1.

of the compound is represented by K. The compound is said to be in equilibrium with solutions represented by points on the curve from R to S at the temperatures indicated. This leads to the conclusion that the same solid can be in equilibrium at the same temperature with two solutions which differ as to concentration. This is however, strictly speaking, impossible. There are two components in there phases including vapor), and the system is monovariant. If we arbitrarily fix the temperature, the composition of the liquid and of the solid phases are defined. There is only one composition of solution which is in equilibrium with a solid phase at one temperature. Clendinnen and Rivett (*Jour. Chem. Soc.*, 1921, CXIX, 1336) have shown the same thing from a slightly different point of view. If at one temperature only one solution of a definite composition can be in equilibrium with a solid phase, with what solid phase is the other solution, which is usually thought to be in equilibrium with the compound, really in equilibrium?

Blasdale ("Equilibrium in Saturated Salt Solutions." The Chemical Catalog Co.,

1927, p. 59), states that a pure hydrate at one temperature can be in equilibrium with two solutions which differ as to concentration, due to the fact that there are two sets of concentration and temperature conditions which satisfy all the mathematical equations demanded by the equilibria concerned. This is merely avoiding the question. If he logically followed this argument, he must say that for the similar case in a ternary *system an infinite* number of sets of concentration and temperature conditions satisfy all the mathematical equations demended by the equilibria concerned. The phase rule would then be of little use.

Very often it is found that the composition of the solid phase in equilibrium solutions of veryinq composition, varies continuously. A temperature-composition diagram of such a system would be as represented by Fig 2. Solution X is in equilibrium *with solid of composition* C[1]. Solution Y is in equilibrium with solid of composition D[1]. The solid phases here are described as being soild solutions of components A and B. This is a two component system in three phases (vapour included); and if we state that the temperature is fixed, there is only one composition of liquid in equilibrium with each composition of solid. This is in agreement with the phase rule.

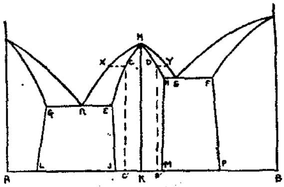

Fig. 2.

In the first case given there should be a definite and individual solid phase for each composition of the solution at one temperature. Fig. 1 is essentially the same as Fig. 2 except that EN and HN almost coincide and it is represented in the diagram by the line KN. In Fig. 1 the difference between a solid of composition C and a solid of composition D cannot be shown by ordinary analysis. We realise that the solidus curve differs from the perpendicular to the composition axis only when a solid component is appreciably soluble in the other solid component or solid compound. A system that is described by Fig. 2 would be recog-

forms solid solutions. More accurate analysis would be necessary before we would *recognise* that solid solutions were formed if the system acted as is indicated by Fig 3; and it is only the unrealisable limiting case that is indivated by Fig. 1.

T. W.Richards (*Jour. Amer. Chem. Soc.*, 1911, XXXIII, 888, states that $CuSO_4$, $5H_2O$ and $8CdSO_4$, $8H_2O$ crystallise from water as a solid solution of water in $3CdSO_4$, $8H_2O$. The evidence for his statements is that these salts when crystallised from water solution contain more water than the *theoretical amount* for $CuSO_4$, $5H_2O$ and $3CdSO_4$, $8H_2O$ after care is taken to avoid entrapped or occluded water. The $CuSO_4$, $5H_2O$ crystallised from water solution contained 36.11 per cent. of water instead of the theoretical 36.07 per cent. These figures show that the usual analysis made on compounds will not distinguish solid solution from pure compound formation when the solubility of one component in the compound formed is very small.

It can further be said that the lines EJ, GL, HM, and FP of Figs. 2 and 3 also ex-

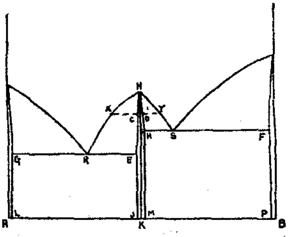

Fig. 3.

ist in Fig 1, but are so close to the 0 an and 100 per cent. component A lines tha their presence is usually not recognised Just as we state that no substance is er tirely insoluble in a liquid, so can we sa that no substance is entirely insoluble in solid. This was recognised by van't Hof (*Jour. Chem. Soc.*, 1890, LVIII, 1,044; *Z Physik. Chem.*, 1890, v, 322).

To discuss a ternary system let us tak the system Na_2CO_3-K_2CO_3-H_2O invest gated by Hill and Miller, (*Jour. Ame Chem. Soc.*, 1927, XIXX, 669), and conside the isotherm at 80° (Fig. 5, p. 680). Fig. is a copy of the features of this diagram th concerns this discussion. The authors sta that Na_2CO_3, K_2CO_3 is a compound, b that the solids in equilibrium with K to

in their diagram are solid solutions. In what do they differ? The authors show Na_2CO_3, K_2CO_3 in equilibrium with solutions that vary continuously within certain limits. This, however, is contrary to the phase rule. There are three components in three phases (including vapor). The system is divariant. If we fix the temperature and the composition of the solid phase, the composition of the liquid phase becomes defined. There is only one composition of solution (liquid) in equilibrium with the pure compound Na_2CO_3, K_2CO_3 unless we assume as Blasdale must, that an infinite number of sets of concentration and temperature conditions satisfy the mathematical equations demanded by the equilibria concerned.

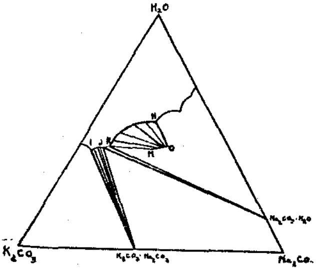

Fig. 4.

The solubilities of Na_2CO_3 and of K_2CO_3 in the compound Na_2CO_3, K_2CO_3 are too small to be recognised by the methods of analysis used, and yet it must exist. On the other hand Na_2CO_3 and K_2CO_3 are quite soluble in the hydrated compound $NaKCO_3$, $6H_2O$ or Na_2CO_3, K_2CO_3, $12H_2O$, and because of this relatively high solubility, solid solution is recognised by ordinary analysis. A similar case exists in the system K_2SO_4-Na_2SO_4-H_2O, Blasdale, "Equilibria in Saturated Salt Solutions," Chemical Catalog Co., 1927. Footnote, Page 84, where Na_2SO_4 is somewhat soluble in the compound $K_3Na(SO_4)_2$.

In the diagram of Hill and Miller, the point representing Na_2CO_3, K_2CO_3 should be a line similar to NO in the same diagram but too short to be determined by the usual analysis. The authors themselves state that "We are not prepared to affirm, however, that there is no possibility of solid solution of anhydrous sodium carbonate in this compound." They, moreover, show data strongly indicating solution of Na_2CO_3 in the compound Na_2CO_3, K_2CO_3, but they do not seem to be aware that it must exist to some extent. In discussing the solid solution they state "the solid phase is a ternary solution, and in no sense a single compound . . .", even though they found the molecular ratio of Na_2CO_3 to K_2CO_3 to vary to both sides of a 1 to 1 ratio. There is no qualitative difference but merely a quantitative one between what was assumed to be 'pure' compound and solid solution of one component in a compound.

Clendinnen and Rivett (*Jour. Chem. Soc.*, 1921, CXIX, 1,337), say that a pure compound is only one of a series of solid solutions with an excess of each component over the theoretical amount to form the compound. In view of other well-known reasons for assuming compounds to be indicated by such temperature composition curves.

In this connection see Washburn, *Tech. Quart.*, 1908, XXI, 360; and Denison, *Trans. Faraday Soc.*, 1912, VIII, 20, and inasmuch as in most cases the excess of one component over the theoretical amount to form a compound is very small, it seems to be more logical to hold that a compound as well as solid solutions of either component in the compound are formed when the temperature composition curve is of the type of Figs. 1, 2, or 3.

Contribution from—
The Dept. of Chemistry,
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THE POLLUTION OF TIDAL AND NON-TIDAL RIVERS.

By J. H. COSTE, F.I.C., F. Inst. P.

(Abstract of a Paper read before the Chemical Industry Conference, Monday, May 14. Chairman: The Rt. Hon. Lord Desborough, K.G., G.C.V.O.).

The facility with which garbage and debris of all kinds is carried away from the place of deposit by running water, must in early days have led to serious pollution of rivers in civilised countries.

The growth of industrialism, more particularly it may be said of chemical industries, added new sources of pollution. What more convenient source of water for industrial operations than the nearest river, and what easier way of getting rid of waste and foul liquors than discharge into the lowest available point of the stream? The ecology

of fluvial life was not much studied in the early years of industrial expansion, hence the neglect of many of the streams which were allowed to be polluted.

The most common and oldest form of pollution of rivers is with domestic refuse and sewage; more specialised cases of organic matter are the refuse from beet sugar works, from wool washing, from tanneries, distilleries, and mill products works.

Another serious pollution from the fishery point of view is road tar which is washed by rain into rivers and brooks near roads, with fatal results to trout and other fish. The physical effects of pollution are that the water may assume a whitish or greyish opalescence, the banks may be stained black, the surface where any contamination will concentrate is scummy. The stones, if any, in the shallows are covered with green or blue-green algae.

The general effect of all pollution is to degrade or destroy normal life in and by the affected stream. It may surplant or supplement normal flora and fauna by other organisms, which, even if they cannot thrive, may survive sufficiently long in the river to render it either totally unfit for the source of drinking water, or may necessitate a more or less elaborate system of storage, filtration, chlorination or other means of purification before it can be properly so used.

A vast amount of systematic information is being accumulated by the Ministry of Agriculture and Fisheries which has undertaken surveys of many rivers in all parts of the country. This work is being undertaken mainly from the fishery point of view, as the fitness of water for maintaining fish life is frequently a matter of great importance. The chief causes of unfitness of water for fish life are the deficiency or great excess of dissolved oxygen, the presence of specifically toxic substances or fine suspensions, the absence of necessary salts, or an unsuitable temperature.

As guides to the management of works as to what sort of effluent may be discharged, and as an aid to the River Authority and to the courts hearing pollution cases, either an effluent may be required to be of a definite quality or strength or it may be required merely to be harmless to the river into which it is discharged. From the point of view of the undertaking, it is perhaps easier to have a definite standard to try to work to, based on simple analytical data, which can

No River Board is doing its duty if it does not continually satisfy itself by the best means in its power not only that the standards for effluents are observed, but that they are adequate for preserving the river in a normal condition under all variations of fresh water flow and temperature.

The main points are that the potential polluters must know what they may and may not discharge into the river, and the river authority must be satisfied that its requirements are complied with and that they are both adequate and reasonable. Each river is different from all others and standards may therefore reasonably differ.

The system of interesting local people in river surveys and stirring up a civic and æsthetic conscience, which is carried out by the Ministry of Fisheries, followed up by tactful and forceful appeals to those in charge of works, will do more to remedy the evils of pollution than premature resort to the law. The legal remedy is always in reserve when all other means of action have failed.

OVERPOTENTIAL IN METALLIC CATHODES. SILVER IN NEUTRAL AND ALKALINE SOLUTIONS.

By Julius Grant, M.Sc., A.I.C.
(*Faraday Society, January* 25, 1928.)

The present research is one of a series that is being carried out, on the suggestion of Dr. H. Sand, on the relation between polarisation during the passage of a current, and on other factors. Those principally to be considered are the nature of the electrolyte and of the cathode. Previous work has shown that when cathodes are polarised with increasing current densities and the polarisations or overpotentials are measured by the so-called "commutator" method at definite intervals after breaking the current, well-defined maxima are obtained in al lcases. The values found depend on the time intervals, which should therefore always be stated, and measurements have been carried out for intervals down to 1.1×10^{-4} seconds after the breaking of the current. When the polarisations are measured during the passage of a current by the so-called "direct" method, no such maxima are obtained, but in nearly all cases inflexions or abrupt changes in direction in the polarisation-C.D. curves are observed, and these appear to be related to the maxima found by the commutator method.

data of the type just described have been determined for silver cathodes in solutions of neutral and alkaline electrolytes.

PRELIMINARY EXPERIMENTS.

Difficulties were experienced at first in obtaining reproducible results, particularly in fairly strong sodium hydroxide solution, and these were traced in every instance to the formation of a spongy, black deposit which appears to be produced particularly readily where local high C.D.'s have been used. When working by the commutator method steady rises in the overvoltage took place with increase of time and C.D. which were not reproducible and were specially marked when successive experiments on the same solution were carried out. At the same time a considerable quantity of the black deposit was produced on the cathode, in the solution, and even on the anode. When this was removed the variations were less marked. It was found that the use of a cylindrical platinum anode which entirely surrounded the whole cathode portion of the apparatus removed these difficulties, due presumably to the production of a uniform C.D. on the electrode. It was thus found necessary to remove all traces of deposit from the apparatus between experiments. The effect is independent, within limits, of the purity of the solution used. The results are further stabilised if the solution is stirred by a stream of hydrogen bubbles, and the effect of oxygen from the anode is minimised by placing the latter well above the cathode.

CONCLUSIONS.

1. The overpotential, as defined in the introduction, of a silver cathode in a number of neutral and alkaline solutions has been investigated.

2. The overvoltage increases rapidly with the duration of the electrolysis up to a certain point, when it remains constant. The time taken to arrive at this point decreases as the electrolytes approach the neutral-point.

3. The overvoltage as measured by the direct method increases rapidly with the C.D. and the overvoltage C.D. curves show a point of inflexion, or change of direction at a certain point.

4. This point is close to the values of the overvoltages obtained by the "commutator" method.

5. The overvoltages obtained by the commutator method increase rapidly with the C.D. up to a point, beyond which it remains constant.

6. The decay-curves of polarisation sink to a value which remains nearly constant over a considerable time and which usually approximates to those obtained by the above methods.

7. A linear connection between the p_H voltage and the overvoltage of the solution is indicated graphically. The deviations may possibly be due to secondary influences yet to be investigated.

Considerations based on the buffer actions of the various solutions and on the effect of an insoluble layer on the electrode fail to account completely for the deviations, but the possibility of compensating influences cannot be ignored.

8. The conditions of the formation of a black deposit on the silver, and the effect of this on the overvoltages have been investigated.

9. In general the results are analogous to those already obtained for an antimony cathode in neutral and alkaline solutions.

GENERAL NOTES.

BRITISH INDUSTRIES FAIR.

40 PER CENT. INCREASE OF STANDS FOR 1929.

In a letter sent to British manufacturers on June 18, enclosing application forms for space in the London section of the British Industries Fair, 1929, the Department of Overseas Trade states that owing to the success of the last Fair (which was a record for space let, the number of exhibitors and the number of overseas buyers), it had been found necessary to provide an extra hall giving 100,000 square feet of stand space in addition to the 250,000 square feet of stands occupied at the last Fair—roughly a 40 per cent. increase.

It is further stated that provisional applications for space at White City amount to two-thirds of the total new stand area so intending exhibitors are advised not to delay their applications.

In Birmingham the increase of space will bring the exhibition area to about 250,000 square feet, making a total area for both sections of the Fair of over 600,000 square feet.

It is expected that there will again be a full representation in the Empire Marketing Board section at White City of the Dominions and Colonies, with the addition probably of one of the big Dominion which has not participated so far—Canada.

"I have every reason to believe that the 1929 Fair will eclipse even the record of the last Fair," Mr. Douglas Hacking, M.P., Parliamentary Secretary to the Department of Overseas Trade said today. "We are again enlisting the help of our overseas officers to make the Fair still more widely known in all countries abroad and we are again spending £25,000 in advertising."

The Fair will begin as usual on the third Monday of February—the 18th in this case—and will end on the Friday of the following week—March 1st.

Public interest at White City was so great this year that it has been decided to open the next Fair to the public at four o'clock instead of five each evening.

GERMANY'S STEPS TO MAKE COAL PAY.

Concentration on Utilisation of By-Products.

A significant development in the German coal industry recently has been the remarkable attention paid by coal-owners to the development of coal by-products. Recent improvements in the methods of firing ovens have permitted the inferior grades of coal and gas to be profitably utilised, and drastic economies in the industry to be effected. Coke by-products have been released, and improvements in gas-pipe manufacture and methods of joining have made it possible to distribute this gas to a distance of 200 to 300 miles from the coke-ovens. Side by side with these developments German coal-owners are expanding and improving their chemical plants in order to make fullest commercial use of the by-products, which are being released, and particular activity is taking place in the production of synthetic nitrate fertilisers.

Virtually all coal and coke producers of the Ruhr have now banded themselves together in a company called "The Ruhr Gas Corporation," which is financed by Dillon Read & Company, the American Bankers, and has been formed to make fullest commercial utilisation of the coke-oven gas produced in the Ruhr. It is estimated that this surplus coke-oven gas is worth about 9 per cent. of the total value of the coke plant production. The coke itself is worth about 75 per cent. of the total value, while tar, nitrogen, benzole and surplus gases each represent about 21 million tons of coke, which the companies associated in the Ruhr Gas Corporation produce annually, a saving of at least 3 marks per ton will be effected on production costs through utilisation of by-products. This represents a total saving of about £3,150,000 per annum.

While the Ruhr Gas Corporation is mostly concerned with the distribution of gas, and has already about 160 miles of pipe-line laid in the Ruhr, the company is also helping individual coke-oven owners in installing plant for cleaning and compressing the gas. The coke-gas contains both sulphur and naphthalene. Removal of the latter is important because of its clogging effect on the line when sent under high pressure. Washing out naphthalene is done by a recent Stinnes process which consists in passing the gas after compression through a bath of oil heated to 180° C.

Long distance piping of coke-gas has been unsatisfactory in the past owing to heavy leakage. This is now being redneed through improvements in pipe and welding methods. Pipes of gas welded steel are about 48 feet in length and are expanded at one end so as to form a ball for insertion of the spiggot of the joining pipe. All joints are gas welded. The pipe is wrapped with jute and covered with asphalt, thus wastage which under old piping methods so often was as high as 30 per cent., is now reduced to a trifle.

Supplying cheaper gas to the country will stimulate home use. Germany will probably double home consumption in the next few years. Assurance of an ample, steady and even quantity of gas may well increase German industry's consumption several times over within the next decade.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

1928 Meeting in Glasgow, September 5 to 12.

Arrangements are now well advanced for the 98th Annual Meeting in Glasgow in September. The President this year will be Prof. Sir William H. Bragg, K.B.E., D.Sc., D.C.C., Ll.D., F.R.S. The meeting opens on September 5 and winds up on Wednesday, September 12.

The reception room will be at the University, Glasgow. It is interesting to note that this is the fifth occasion on which the Association has met in Glasgow, the other occasions being in the years 1840, 1855, 1876 and 1901. Since 1840, the year of the first meeting, Glasgow has made great strides in population and material pros-

perity. The members who attend will be sure of a great welcome, while the arrangements for excursions and sight-seeing will be on a lavish scale. By arrangement, we learn that the railway and steamship companies will make liberal reductions on the fares usually charged to travellers to Glasgow. There is sure to be a good number of overseas visitors present.

ACTIVITIES OF THE INSTITUTE OF METALS.

The Liverpool Meeting of the Institute of Metals, to be held on September 4—7, is proving very attractive. Already over 200 Members—including many from overseas—have indicated their intention of taking part in the Meeting. The papers to be presented include a valuable series dealing witb the die-casting of alloys, as well as the Eighth Report to the Corrosion Research Committee. A " full-dress " discussion of corrosion problems will form a feature of the meeting. It is particularly appropriate that this discussion should take place in a maritime centre such as Liverpool. On the social side the gathering promises to be a pleasant one; a series of receptions, visits to places of interest and other functions, is being arranged by the Local Reception Committee. On July 4 an election of Members is taking place in connection with the Liverpool Meeting, full particulars of which can be obtained from Mr. G. Shaw Scott, M.Sc., Secretary, Institute of Metals, 14, Members' Mansions, Westminster, London, S.W.1.

ABOUT IRON AND STEEL.

By Prof. H. C. H. Carpenter.

Until about 70 years ago wrought iron was the principal " constructional " metal at the disposal of the engineer. It possessed elasticity, mechanical strength, ductility, malleability, toughness and some resistance to corrosion in the atmosphere. It was used for a great variety of purposes—rods, tubes sheets, plates, girders, rails, bridges, boilers and ships. Essentially it was commercially pure iron and in particular it did not contain, apart from slag, more than a small amount either of carbon or of any other element. Steel of course had long been known, made either by the cementation or crucible process. It might contain anything from about 0.5 to 1.5 per cent. of carbon, the effect of which was to harden the iron. his hardness could be still further increased by quenching in water from temperatures above 750° C. The steels of that period were used almost entirely in the form of tools. Owing to their cutting hardness they were used for machining the much softer wrought irons used for engineering purposes.

The advent of Bessemer steel and Siemens steel about 70 years ago placed in the hands of the engineer new and more varied constructional materials. The steels produced by these processes were softer than tool steels, and, in fact, some of them were quite as soft as wrought iron. It was possible, however, to control the degree of hardness by regulating the percentage of carbon. Such steels could be produced in large masses and their working up into finished products involved a new technique. Whereas wrought iron could only be built upon large pieces by welding together several smaller pieces, steels made by the Bessemer and Siemens processes were produced from large ingots weighing many tons which were reduced by mechanical work to the appropriate size and form. In the course of time carbon steels, with a great variety of properties, became available, and the range of properties was still further increased by careful heat-treatments to which most of them were susceptible.

It did not take long for these discoveries to affect the position of wrought iron as a constructional material, and gradually steels have displaced it from its exclusive position. For certain purposes it stil lholds its own and something like 1,000,000 tons are manufactured annually even at the present time. As against this, the annual production of steel is of the order of 80,000,000 tons, and as a constructional material it has replaced wrought iron for all except certain special purposes. Two factors have brought this about. The first is that wrought iron is a comparatively soft material, whereas the hardness and other properties of carbon steels can be varied to a great extent by varying the percentage of carbon. The second is that, speaking broadly, the properties of wrought iron are unaffected by heat treatment, whereas those of al lsteels containing above about 0.35 per cent. of carbon can be varied to a great extent. For many years, therefore, the heat treatment of steels was carefully studied. In the early days knowledge had to be acquired more or less empirically. The birth and development of metallography, however, about 40 years ago changed all this, and from about 1890 onwards, it has been possible to study the heat treatment of any steel in a scientific manner.

The most important property of steel, so far as heat-treatment is concerned, is its capacity — so long as the carbon exceeds about 0.35 per cent.—to be hardened by quenching in water from above 750° C. Provided the chilling is sufficiently quick, the hardness of steels can be increased about six times by this process. After hardening, the steel is brittle and requires to be toughened by tempering, *i.e.*, by heating to a particular degree of temperature between 200° and 350° C. According to the temperature used the degree o fsoftening can be adjusted. In this way hardened and tempered steels can be produced and used for a great variety of purposes.

THE EARTH.

Dealing with the structure and temperature of the earth, a scientific correspondent of the *Times* says that its interior has a high temperature, as is shown by the fact that all deep-seated rocks have either been melted or re-crystallised under great heat, by the molten condition of lavas extruded through the crust, by the warmth of deep mines, and the existence of hot springs. The average rise has been estimated at about 1 deg. Fahr. for every 58ft. of descent. The inner mass is much heavier than the crust, the average specific gravity, or weight as compared with an equal bulk of pure water, being about 5.7 and of the crust about 2.5.

The earth, moreover, is composed of zones. There is a central core which does not propagate earthquake shocks, occupies about one-fifth of the whole diameter, and probably consists of gaseous material at a very high pressure, a massive portion in all probability composed of nickel-iron, like meteorites, and an outer layer, on the average 40 miles thick, very varied in its structure and composition, but with radio-active materials.

However the earth assumed its present phase, its crust was at one time very much hotter than it is at present, and must be regarded as undergoing a slow process of cooling, radiating its heat into outer space. It is now known that the process of cooling is retarded by liberation of heat from the slow disintegration of uranium and thorium. Dr. J. W. Evans has pointed out, however, that the whole of the energy from the decay of the ratio-active elements is not given off as heat. Much of it is probably absorbed in producing changes in the surrounding materials, evidence of which is found in the haloes surrounding the microscopic fragments of radio-active matter.

The rate of the earth's rotation has been falling, although excessively slowly, thus reducing the centrifugal force which made the globe wider at the equator than at the circumference of the plane passing through the poles. There must, therefore, be a flow from the equatorial plane towards the poles, with consequent distortions and folding of the surface. Tidal action may result in an east to west movement of the crust relatively to the core.

LIVINGSTONE COLLEGE.

LEYTON, LONDON, E.10.

Commemoration Day was held at Livingstone College on Friday, June 15, 1928. A large gathering met in the grounds of the College.

The chair was taken by G. Carmichael Low, Esq., M.A., M.D., F.R.C.P., Senior Physician, Hospital for Tropical Diseases and Seamen's Hospital, who gave a brief resumé of the advances that have been made in tropical medicine during the last 40 years, and emphasised the importance of special training in this branch of medicine to all who go abroad. He spoke of the discovery of Sir Patrick Manson that Filariasis is spread by a mosquito—or Sir Ronald Ross as to the transmission of Malaria—of Sir David Bruce as to the spread of Tsetse Fly Disease. Dr. Low dealt with the conquests made with regard to Yellow Fever by an American Commission in Havana; with the discovery by Sir William Leishman of the cause of Kala-azar, and told of the progress that has been made with regard to plague. He related the new forms of treatment for these diseases, which are much more efficacious than any of the older drugs used some years ago, and of the advances made in the knowledge of prophylaxis. "Though it is impossible," he said, "to give laymen such advanced courses on tropical medicine, yet it is essential that such people should not go abroad ignorant of the elementary facts and it is here that Livingstone College is playing its part, and playing that part so well in giving its courses to missionaries who will subsequently go to the different parts of the globe. The value of the teaching cannot be overestimated. Every year, and this one I see is to prove no exception, men get up and tell how the teaching obtained at Livingstone College has enabled them to save life, how it has tided them over difficulties and

how it has helped them to preserve their own health and keep well and fit when others are ill and dying. We now know that many of the students of the College are treating Yaws, Sleeping Sickness and Leprosy under the direction of Government Medical Service in Africa and other lands. The Southern Rhodesian Government are now making money grants to those who have had the full training here at Livingstone College to help them with their dressings and medicines. In my own share of the teaching at the College, I give the men taking out the courses, as much clinical instruction as one can, and show them as many tropical cases as possible at the Seamen's Hospital at the Albert Docks, so that when they meet these for themselves they will know what to do, what drugs to give, and how to look after the patients till the doctor arrives. It is astonishing how a little knowledge of some simple fact may influence the progress of a disease and how nursing may make all the difference between life and death. I may only quote blackwater fever to emphasise this point. . . I hope, then, that everyone present, or those who are not, will help to maintain Livingstone College and the good it is doing. By doing so, they will be helping a great work and benefiting humanity at large, not only at home but in the very remotest parts of the globe."

Mr. S. Peake, who has been working in South India for the past twenty-nine years, drew attention to the object of the College teaching—to teach missionaries how to care for their own health and the health of their fellow missionaries when far from qualified medical aid.

The Principal reported that 1,020 students had passed through the College, and begged for the support of Missionary Societies by sending their candidates for training.

The College is in need of £400 to close the financial year without a deficit on the year's working.

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.

On Thursday, June 14, the following papers were read :—

Myothermic Apparatus. By A. V. Hill, F.R.S.

Improvements in myothermic apparatus have made it possible to measure with relative accuracy, in the sartorius of the frog or any similar muscle, not only the heat suddenly liberated in a contraction, but also that liberated over long intervals at rest or in recovery, or as the result of prolonged discontinuous stimulation. A Zernicke moving-coil galvanometer (Kipp) has been employed. The total heat has been measured from the area of the deflection-time curve. The temperature of the muscle chamber has been maintained constant within 0.001° C. An "all-metal" thermopile has been devised which responds quickly, settles down rapidly and is very completely insulated. A Ringer's solution containing phosphate (7 to 15 mgms. per cent.) has led to improved performance in the isolated muscles employed.

The Rôle of Oxidation in Maintaining the Dynamic Equilibrium of the Muscle Cell. By A. V. Hill, F.R.S.

The resting heat-rate of frogs' sartorius muscles has been investigated in oxygen and under strictly anaerobic conditions. The resting heat-rate in oxygen agrees with existing determinations of the rate of oxygen consnmption, and tends to diminish rather than to increase during survival or as the result of stimulation (after recovery). The minimum resting heat-rate in the absence of oxygen is sufficiently accounted for by lactic acid formation. Stimulation produces an immediate increase in the anaerobic resting heat-rate which, under conditions of advanced fatigue, may reach considerable values. This increase persists for many hours, long after the muscle has become inexcitable. A linear relation exists between the increment in anaerobic resting heat rate and the energy liberated by previous enaerobic stimulation. The total heat in eight hours due to the anaerobic resting heat-rate may be as great as 5 calories per gram of muscle : the maximum rate may be as high as 1i4 calories per gram per hour. The quantities involved are so great that the phenomenon described cannot be due simply, or indeed largely, to enhanced dactic acid formation. Resting anaerobic survival without stimulation leads gradually to the same high heat-rate. Increased acidity is not the cause of the phenomenon. The effect of anaerobic stimulation in increasing the resting heat-rate can be reversed, partially or completely, by recovery in oxygen. The possibility of oxidation leads to the inhibition of reactions previously occurring. The rôle of oxidation in maintaining the chemical and physical architecture of the cell is discussed. The degenerative changes set u pby anaerobic stimulation, or survival, proceed at a rate determined at any moment by the degree of oxygen want. Oxidation

tegrity of boundaries, or membranes, which are essential if the organised system is not to become a chaos of biochemical processes.

The Absolute Value of the Isometric Heat Coefficient Tl/H *in a Muscle Twitch and the Effect of Stimulation and Fatigue.* By A. V. Hill, F.R.S.

Direct observations of T and H give a mean value of the isometric heat coefficient Tl/H = 6.16. This is in close agreement with the value calculated from the lactic acid data of Meyerhof. Previous anaerobic activity, liberating a large fraction of the whole energy available, has little or no effect on the isometric heat-coefficient. The effect, if any, is in the direction of a slight reduction; in extreme fatigue, however, the reduction is large. The result, therefore, of chemical studies of muscle (which have necessarily employed a large number of twitches) are applicable directly to a case of a single twitch. Recent work on "phosphagen" is discussed in view of the results.

The Absence of Delayed Anaerobic Heat in a Series of Muscle Twitches. By A. V. Hill, F.R.S.

In a series of muscle twitches, in the absence of oxygen, there is little or no heat-production except during the contractions themselves; the "total" heat is equal to the "initial" heat. Hence the lactic acid formation—which must be accompanied by heat-liberation—occurs entirely during contraction. The contrary conclusion of Embden, Lehnartz and Hentschel, the experimental base of whose work has been criticised by Meyerhof and Schulz, rests on imperfect reasoning: the method they adopted could not lead to a decision of the question.

The Recovery Heat-Production in Oxygen after a Series of Muscle Twitches. By A. V. Hill, F.R.S.

The ratio $\frac{\text{Total heat in oxygen}}{\text{Total heat in nitrogen}}$ for the case of a series of twitches, reckoning heat per unit of mechanical response developed, has a mean value of 2.07. This allows us to calculat the "oxidative quotient for lactic acid," and the result, 4.81, agrees well with the mean value, 4.7, of Meyerhof and Schulz, deduced from experiments involving lactic acid and oxygen measurements. The "isometric heat coefficient" Tl/H is the same in oxygen and in nitrogen, confirming the conclusion of Weizsäcker and others that [illegible] is entirely non-oxidative in

THE OPTICAL SOCIETY.

At the meeting of the Optical Society, held at the Imperial College of Science and Technology, South Kensington, on Thursday, June 14, 1928, the following papers were read and discussed:—

The Errors of a Reflectin Prism. By Instructor Capt. T. Y. Baker, F.Inst.P., R.N.

A prism with two reflecting faces designed to fulfil a particular purpose in an optical instrument gives rise to errors due to (a) inaccuracy of manufacture, and (b) inaccuracy in mounting the prism in the instrument. The effects of these errors are investigated.

The special case of the constant deviation prism, in which the three parts of the ray inside the prism nominally lie in a plane, gives rise to an error of the second order, the value of which is obtained.

A Trichromatic Colorimeter with Special Primaries. By W. D. Wright, A.R.C.S.

The paper describes a trichromatic colorimeter that has been specially designed in order to make an accurate re-determination of the locus of the spectral colours in the colour triangle for as many observers as possible. A spectrometer system is used in which two spectra are formed from the same source. From one of these, three portions to act as primaries are reflected back through a lower part of the dispersing system, so that the mixing of the three radiations is effected by neutralising the prismatic dispersion by which the colours were first separated. From the other spectrum the test colour and a desaturating colour are selected and mixed in a similar manner, and the composite beams are then brought into the two halves of a simple bi-partite field. In the process of being mixed with the other colours, each spectral colour is filtered by its return passage through the dispersing system and the instrument thus becomes very effective in removing stray light. Another device has enabled the Maxwellian method of observing the field of view to be adopted without the introduction of rotating parts into the system. The intensities of the three primaries are controlled with photometer wedges.

The Theory of Aplanatic Surfaces. By T. Smith, M.A., F.Inst.P.

The necessary and sufficient condition that an optical system should have a pair of aplanatic surfaces is that the eikonal of the system can be expressed as a homo- nature.

geneous function of the first order of three variables, each of which is a linear function of the direction cosines of the ray in the object and image spaces. Methods are given for finding the equations of these surfaces when the eikonal is given, and for finding the eikonal when the surfaces are given. Conjugate aplanatic surfaces are similar apart from arbitaray uniform unidirectional extensions or compressions.

In general only one pair of aplanatic surfaces is possible, but in spherically symmetrical systems two pairs are found. In addition there may be aplanatic imagery at isolated points.

The Primordial Coefficients of Asymmetrical Lenses. By T. SMITH, M.A., F.Inst.P.

An easily calculable system of sixteen magnitudes is constructed for the representation of the properties of asymmetrical lenses by the addition of four lengths to the magnitudes previously used. The equations connecting this system and the coefficients of the eikonal and of the characteristic function, the equations for combining systems or moving their reference points, and the identities between the coefficients are expressed in matrix form. It is shown that the eleven variables present in a system of three separated astigmatic yenses only yield nine degrees of freedom, and such a system cannot, if the reference points are placed where the outer lenses meet the axis, represent the general system, which has ten degrees of freedom.

Note on the Use of Lenses in Series for Sight Testing. By T. SMITH, M.A., F.Inst.P.

The paper deals with the theory of a train of lenses placed in series as used in a trial frame or other instrument. The series arrangement enables a small number of lenses to be combined to give the correction for any regular defect of form. It is shown that in general effective powers are not simply additive, but under conditions described in the paper the error made in regarding them as additive becomes small. The conditions involve the order of the lenses and the position of every lens except the first of the train. It is always possible to satisfy these conditions in a system designed for use in the way described. With incorrect arrangements serious errors may be made.

A series of beautiful lantern slides illustrating Studies in Diffraction, prepared by the late F. W. Shurlock, B.A., B.Sc., F.Inst.P., were exhibited by the Honorary Secretary (Papers) by the kind permission

On the motion of the President, the meeting resolved that the Secretary should write to Mrs. Shurlock expressing the thanks of the Society to her for affording them the opportunity of seeing these slides.

MINERALOGICAL SOCIETY.

June 12, Dr. G. T. Prior, F.R.S., President, in the chair.

Place-Names of Mineral Localities in Central Europe. By PROF. F. SLAVIK AND DR. L. J. SPENCER.

Many important mining districts in the former Austro-Hungarian monarchy are now in other countries and the localities are now known officially by other names. Lists are given for each county and province with equivalent place-names in the various languages (fifteen in all), together with a statement of the principal minerals from each locality. A key to the pronounciation of letters with diacritical marks and a glossary of geographical terms that enter into the construction of place names are added.

...Eleventh List of New Mineral Names. By DR. L. J. SPENCER.

The first list of this series was published in 1897 and gave all the names of minerals not in the sixth edition of Dana's "System of Mineralogy" (1892). Others have appeared every three years at the end of each volume of the "Mineralogical Magazine." They are intended as dictionary lists of new names rather than lists of new minerals. About 170 names are now added.

On the Atomic volume Relations in Certain Isomorphous Series III. By A. F. HALLIMOND.

In the preceding parts of the paper it was shown that the volume-differences in isomorphous series derived from the same group of eutropic elements stood in a constant ratio in all series, and that this relation could be used to calculate atomic volumes for the elements in the combined state. It is now shown that compressibilities agreeing with those determined by Slater for eleven alkali halides can be calculated from the atomic volumes already assigned to the combined elements, by means of the relations $\beta = V/K \; \beta^1 = V^1/K^1$, where β, V, are the compressibilities and atomic volumes of the combined metals; β^1, V^1 those of the halogens. For all the metals K has the value $\cdot 4 \times 10^{-6}$, for the halogens K^1 is approximately $\cdot 2.5 \times 10^{-6}$. The compressibi-

volume relations and the compressibilities in the combined state, are shown to be consistent with relations of the type $pv = K$, already indicated by Richards for the free metals; K, the constant for the eutropic group, assuming a new value in each isomorphous salt-series. The atoms thus behave as regions of a perfect gas under a high pressure.

On the Determination of Optic Axial Angles and Crystal-forms from Observations by the Becke Method in Thin Sections. By H. Collinridge.

A suggested method of combining separate observations of different sections in one stereographic diagram and incidentally finding from the combined diagram the forms and axial ratios and optic axial angle of the crystal. The method is illustrated by an example of Olivine in an olivine-basalt.

A Contribution to the Petrology of the Whin Sill. By S. I. Tomkeieff.

In this paper are described certain rare varieties of the Whin Sill, such as the coarse gabbroidal rock, occurring in the form og bands within the mass of the normal dolerite, the coarse rock with red granophyric spots, the red felsitic veinlets, and spherical splitic inclusions. A scheme of defferentiation is applied to explain the origin of these varieties.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

At the monthly Council Meeting on June 6, the Chemical Report was submitted by Mr. H. Dent Brocklehurst, chairman, who reported that the list of samples analysed for members by the Consulting Chemist during the month of May had been submitted to the Committee.

Dr. Voelcker, in referring to matters of interest which had arisen out of analyses made by him during the past month, had instanced the case of a farmer who had submitted for examination samples of six different meals that had been supplied to him for pig and poultry feeding. Of the six not a single one was "first class," two were distinctly adulterated—one (barley meal) with tapioca and the other (*middlings*) with rice-husk.

Dr. Voelcker had mentioned that there was at the present time an excellent illustration at the Woburn Experimental Farm of the benefit, in the case of the lucerne crop, to be derived from sowing seed that had been previously inoculated.

Mr. H. D. Brocklehurst moved that the report be adopted. On behalf of the Committee he congratulated Dr. Voelcker on the Birthday Honour he had received on the previous Monday for services, he believed, rendered some thirty-five years ago. He would like at the same time to congratulate Dr. Voelcker on the fact that he had lived for that very considerable period so that he had been able to receive a somewhat belated appreciation of his services. (Applause)

Dr. Voelcker, in acknowledging the congratulations, reminded the Council that it was with their permission and as the representative of the Royal Agricultural Society that he went out to India, and he desired to acknowledge the opportunity they had afforded him. It was a matter of satisfaction to know that the work he had done so long ago had been of value to the recent Royal Commission on Indian Agriculture.

FIFTY-SECOND REPORT OF H.M. INSPECTORS OF EXPLOSIVES.

(H.M. Stationery Office, 9d. net.)

(*Continued from Page 394.*)

The Report says (*inter alia*) :—

Chemical Work.

The following information regarding the Chemical Work done during the year has been received from the Chief Superintendent, Research Department, Woolwich :—

The total number of samples examined during the year amounted to 449, a considerable increase over earlier years. Of these, 269 were inspection samples, 100 from the Customs, 7 from the Testing Station, while 25 were received in connection with gas ignitions and 42 were new explosives. Six special samples were also examined.

Of the inspection samples, 189 of which were Permitted Explosives, 19 were reported against for various reasons, the rest being quite satisfactory. Among the reasons for adverse reports were excessive exudation, low heat test, and wrong composition. Of the new explosives, 27 were found to be satisfactory, while 15 failed to come up to the required standard. All the Customs samples and all the samples taken in connection with gas ignitions were quite satisfactory.

The special samples were examined in connection with accidents and outrages, but only one of these requires special notice. This was a firework composition consisting

of potassium chlorate, aluminium and orpiment received on account of an accident in a factory. The mixture was found to be extremely sensitive to friction and also very violent, and it is not considered that it would be possible to devise any precautions which would make the mixing of such ingredients in bulk and when dry, reasonably safe. It is therefore considered that such mixtures should not be used in future.

A considerable amount of work has had to be done in the modification of analytical methods to make them applicable to explosives containing di-nitro-glycol. The volatility of this ingredient has made many of the old methods inapplicable. An investigation has been started into the "low freezing" properties of di-nitro-glycol and nitro-poly-glycerine mixtures and also into the loss of di-nitro-glycol from explosives containing that ingredient at various temperatures and under different conditions of packing.

An apparatns has been devised and is now being erected to enable temperatures ranging from 0° to -25° C. to be maintained for any desired length of time. It has already been found that the addition of small amounts of nitro-glycol to nitro-glycerine has much more effect in increasing the time taken for freezing than in actual lowering of the freezing point. It appears likely, however, that sufficient nitro-glycol can easily be added to prevent any possibility of the explosive freezing in this country. The freezing point curve of mixtures of nitro-glycol and nitro-glycerine is being determined and also that of nitro-glycerine and nitro-poly-glycerine mixtures.

As was anticipated, it has been found to be absolutely necessary in these freezing experiments to "seed" the cartridge with frozen nitro-glycerine in order to get results that could be repeated. Under certain conditions the time of freezing of explosives can be very much extended. The periods obtained recently for ordinary gelignite vary from 0° C. from 12 hours to over 14 days.

The experiments on the volatility of the nitro-glycol show that even when made up into a gelatinous explosive in parchment paper wrappers and packed in a cardboard box with outer wrapper dipped in paraffin wax, there is a considerable escape of nitro-glycol even at ordinary temperatures.

Work on the properties of tri-nitro-toluol containing water has been done, and it has been found that even when it contained half its weight of water (tri-nitro toluol 66 per cent., water 34 per cent.) it could be de-

None of these investigations could be completed in time for this report, but it is hoped that all, or, at any rate, a good proportion of them, will be ready for inclusion in the next.

Working of the Act by Local Authorities.

We have, as usual, devoted some portion of our time to visiting Local Authorities in various parts of the Kingdom. We were able to visit 106 Local Authorities, and have, as already mentioned, inspected 87 stores and 468 registered premises under their control, generally in company with their Officer appointed under the Act.

The majority of these places were found to be in good order, but, as usual, irregularities were noticed, and in two cases the Local Authorities took proceedings at our instigation. One of the chief benefits of these inspections is that they give us an opportunity to assist and instruct the Local Authority Officers.

There were sold 66 copies of the "Guide to the Explosives Act, 1875," which was originally prepared chiefly for the assistance of Local Authorities.

Accidents.

Generally.—The total number of accidents reported to us during the year was greater than in 1926 owing to the coal mines having been closed for several months in the latter year. The total number of accidents for 1927 was 367, causing 40 deaths and injuries to 365 persons. On comparing these figures with the similar ones for 1925, it will be seen that the total number of accidents shows a decrease of one, and the number of deaths shows a decrease of six, but the number of persons injured has increased by eight.

The average figures for the nine years 1919 to 1927 are in excess of those for the year 1927.

NOTICES OF BOOKS.

La Fabrication Chimique de l'Or Procédés. Jollivet Castelot (Texte Francais) Chez l'Auteur: 19, Rue St. Jean, Douai (Nord), France.

This work of 126 8vo pages, has already received some popularity, having been translated into English, German and Spanish. It will be found of special help and interest to chemists and chemical engineers, to whom it is particularly addressed.

Solubilities of Inorganic and Organic Compounds. A Compilation of Quantitative Solubility Data from the Periodical Literature. By ATHERTON SEIDELL, Ph.D., Hygienic Laboratory, U.S. Public Health Service Washington, D.C. Supplement to the Second Edition. Containing data published during the years 1917-1926. Pp. VI + 567. Price 400 francs. New York: D. Van Nostrand Company, Inc., 8, Warren Street; Paris: Gauthier-Villars et Cie.

The present supplement to the Second Edition of the well known work of the name shewn at the head of this notice has enabled the publishers to bring the information up to date, without going to the great expense of printing the mass of information already included in the second edition. To minimise the inconvenience of having two books instead of one, an index common to both books and supplement has been included at the end of the latter.

Organic Syntheses. An annual publication of satisfactory methods for the preparation of Organic Chemicals. By an Editorial Board as follows, Roger Adams (Editor-in-chief), H. T. Clarke, J. B. Conant, Henry Gilman, S. C. Marvel and Frank C. Whitmore, with numerous contributors. Vol. VIII. New York: John Wiley and Sons, Inc.; and London: Chapman and Hall.

The present volume, which consists of 33 chapters, additions, etc., author and subject indices, follows the plan of the previous volumes. There are, however, given in the present volume directions for producing B.chloropropionic acid first from acrolein and second from trimethylene chlorohydrin, and for producing trimethylactic acid first from *tert*-butyl chloride and second from pinacolone. The binding and general get-up follow the conventional lines observed by the Wiley Publishing Company. The contents of the book are up-to-date and will be found useful by all interested in chemistry.

Bulletin of the Bureau of Bio-Technology. We have received a copy of the Index and Title Page to the Second Volume of the *Bulletin of the Bureau of Bio-Technology.* A limited number of most of the issues remain on hand and can be supplied at the published price on application.

A few complete sets comprising Bulletin Nos. 1-16 complete with Indexes are available and may be obtained for £2 net.

This news may appeal to Libraries and ... their files. Limited, The Cedars Laboratories, Sheen Lane, Mortlake, London, S.W.14; The Bureau of Bio-Technology, Buckingham House, 41, Headingley Lane, Leeds; and Old Basford Mills, Basford, Nottingham.

RECENT GERMAN BOOKS.

(1) *Dispersoidanalyse.* By FRIEDRICH VINCENT VON HAHN. Pp. xxiv + 553. Price 39 marks.
(2) *Nobelvortrage.* Pp. 58. Price 3m. Both from Theodor Steinkopff, Dresden and Leipzig.
(3) *Lehrbuch der Thermochemie und Thermodynamik.* By the late O. SACKUR AND C. V. SIMSON. Pp. xvi + 348. Berlin: Julius Springer. Price 18 m.
(4) *Technische Gase.* By DRS. F. MUHLERT & K. DREWS. Pp. viii + 416. Leipzig; S. Hirzel. Price 22 m.
(5) *Textilchemische Erfindungen.* By DR. A. LEHNE. Second issue. Pp. viii + 74 Wittenberg: A. Ziemsen. Price 6 m.

The 1928 German chemical literature has become expensive for the average Englishman. It will be noted that the above important works all cost more than is asked for a similar work published here. There seems also no abatement in the output of literature relating to various phases of physical chemistry. Von Hahn's extensive volume is really Part 3 of Prof. Ostwarld's *Handbuch der Kolloidwissenschaft* and is mainly concerned with the modes of examination of particles in disperse systems. Every method for obtaining measurements of the size of particles is adequately discussed.

The Nobel lectures by Profs. Perrin, Svedberg and Zsigmondy also deal with aspects of colloidal phenomena. They appeared originally in the *Kolloidchemisches Beiheft.*

Prof. O. Sachur's 1912 Thermochecistry has been revised for the new edition by Prof. Simson and has a foreword by Prof. Haber. A number of new sections have been incorporated and other matter added to bring the work up to date.

The technical gases now include many carbon compounds, Cl, HCl, O_3. HCN, SO_2 and H_2S, as well as many industrial mixtures obtaine dfrom wood, coal and other products, on distillation. All these receive the attention of Drs. Muhlert and Drews in their important contribution to technical

The second issue of Textile (patent) discoveries covers the second half of 1927 and has been compiled from German Patent literature so far as it affects the textile trades.

NOTES ON BLOWPIPE ANALYSIS.

By Prof. Nicholas Knight, Cornell College, Iowa.

The blowpipe was first introduced into analysis by Antone Schwab, a mining engineer of Sweden, in 1738, although used extensively during the last century has now taken a very subsidiary position in analytical chemistry. It is therefore notewothy that Prof. Knight's 20 page brochure has reached a twelfth edition. In addition to the usual tests made with the help of the blowpipe a number of other analytical methods are included so that the booklet serves for the student in his preliminary qualitative work.

FORTHCOMING EVENTS.

ROYAL INSTITUTION.

21, Albemarle Street, W.1.

Monday, July 2, at 5 p.m.—General meeting.

THE INSTITUTE OF PHYSICS.

Public Lectures on Physics in Industry.

The following Lecture has been arranged with the co-operation of the Seventh International Congress of Photography :— No. 14. "Physics in Photography," by C. E. Kenneth Mees, D.Sc., Director of the Research Laboratory, Eastman Kodak Co., Rochester, N.Y., on Thursday, July 12, at 8 p.m., in the Rooms of the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2.

The chair will be taken by Sir William Pope, K.B.E., LL.D., F.R.S., President of the Seventh International Congress of Photography.

THE PHYSICAL SOCIETY.

Visit to Bristol, Saturday, July 7, 1928.

The Council has accepted a kind invitation from Professor A. M. Tyndall to visit Bristol on Saturday, July 7, and to hold there a meeting in the new Henry Herbert Wills Physical Laboratory. The following programme has been provisionally arranged:—

Leave Paddington 8.55 a.m.; arrive Bristol 11.15 a.m. On arrival the party will drive to the Suspension Bridge, Durdham Downs, Shirehampton, and back through Meeting in the Physics Laboratory 2.30 p.m., at which Papers by workers in the Laboratory will be presented.

Tea and inspection of Laboratory, 4-5.30 p.m.

Opportunities will also be afforded for seeing Bristol Cathedral and the Main University Buildings.

The Council has been able to arrange with the Great Western Railway Company for the issue through the Society's office of cheap day tickets (3rd class) at a single fare for the double journey. The cost of the excursion will be 17s. 6d.—namely, railway fare 14s. 9d., lunch in Bristol 2s. 9d.—payable to the Society. Through the kindness of our hosts in Bristol, no charge will be made for tea and conveyances there. In addition, meals—breakfast on the outward journey and dinner on the return journey—will be obtainable on the train at the usual charges.

Members may be accompanied by friends, but tickets will be issued to Members of the Society only.

DUTCH CHEMICAL MEETING AT THE HAGUE.

The Netherlands Chemical Society will hold its annual meeting at The Hague from July 15 to 17. This is the 25th year of the Society's existence and the meeting will be followed by the Ninth Conference of the International Union of Pure and Applied Chemistry (July 18-23). Nearly thirty countries will participate.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

16,580.—American Potash and Chemical Corporation. — Manufacture of boric acid. June 7th.

16,728.—Epner, C.—Production of hydrogen, etc. June 8th.

16,688.—I. G. Farbenindustrie Akt.-Ges. —Alkali phosphates and ammonium phosphates. June 8th.

16,511. Welffens, E. J.—Recovery of chemicals from waste solutions

Specifications Published.

291,522.—I. G. Farbenindustrie Akt.-Ges. —Manufacture and production of derivatives of N-dihydro-1.2.1[1].2[1]-anthraquinone fast to chlorine.

283,868.—Traun, H. O. (trading as Traun & Sohne, Dr. H. Vorm, Harburger Gummi-Kamm-Cie). — Containers for hydrofluoric acid and other highly corrosive chemicals, and materials for the manufacture thereof.

Abstract Published.

289,105.—Lead salts.—Smith, S. C., 701, Salisbury House, London Wall, London.

The lead salts of the acids of arsenic, antimony, chromium, tungsten, molybdenum, and uranium are obtained by reacting an aqueous solution of a salt of the respective acid, or of the acid itself, with "active" lead chloride obtained by precipitating with water a solution of lead chloride in an alkali chloride or in hydrochloric acid. Preferably the "active" chloride is prepared by saturating a boiling brine with sodium chloride and lead chloride, adding the solution to an equal volume of cold water, and removing and washing the precipitated lead chloride, which, for the production of the lead salt, is suspended in a hot or boiling solution of the respective salt or acid. Examples are given of the preparation of lead chromate, arsenate, and tungstate. Specifications 237,308, 239,558, and 239,558 are referred to.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

FUNGOLEUM.

491,283. Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—The Strawson Chemical Company, Limited, 79, £ueen Victoria Street, London, E.C.4. June 13th.

YESTACT.

490,698.—Chemical substances prepared for use in medicine and pharmacy.— —The English Grains Company, Limited, 30, Union Street, Burton-

JUST PUBLISHED.

RASA-JALA-NIDHI

or Ocean of Indian Chemistry & Alchemy

Vols. I. and II.

This is the most Comprehensive and Scientific Treatise on Hindu Chemistry, Alchemy and Medicine—a Science almost lost to Humanity several Centuries ago, and now reclaimed by

Dr. Bhudeb Mookerji, M.A., of 41a, Grey Street, Calcutta.

The text is in Sanscrit and English. Neatly bound in cloth; best antique paper. Demy 8vo. About 350 pages, each Volume. To be had of Messrs. Luzac & Co., Great Russell Street, London, and of the Author in India.

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INDEX.

ABOUT iron and steel, 407.
Absence of delayed anaerobic heat in a series of muscle twitches, The, 410.
Absolute Hartmann test, 155.
Absolute measurement of capacitance by Maxwell's method, 297.
Absolute value of the isometric heat coefficient T1/H in a muscle twitch and the effect of stimulation and fatigue, 410.
Absorption spectra of iron, cobalt and nickel, 23.
Absorption spectra of prototropic compounds, 186.
Abstract service, New, 182.
Accidents in British mines, 353.
Acetic acid, 386.
Acetic acid (New Patent), 239.
Action of Nitrous acid on wool fibre, 60.
Action of sulphuric acid on copper, 81.
Action of thionyl chloride on organic acids, 196.
tions, 212.
Action of copper on sulphuric acid, 257.
Action of diazo-salts on aromatic sulphonamides, 381.
Activated carbon : Some industrial applica-
Activities of Institute of Metals, 407.
Acyl and alkyl phenols, 367.
Adsorbent materials of use in chemical industry, 372.
Adsorption of sugars by animal charcoal and decolorising carbons, 38.
Age and composition of the Whin Sill, 287.
Air resistance to a runner, 122.
Alloy steels : Their manufacture, properties and uses, 307, 324.
Alkaloids of some Indian aconites, 91.
Alkaloids (New Patent), 95.
Ammonaphthoic (New Patent), 255.
Amplitude of sound waves in resonators, 363.
Analcite-syenites and associated rocks of Ayrshire, 349.
Analysis of coal gas, 158.
Analysis of fertilisers, 89.
Analysis of Opal Glasses, 27.
Antimony in Canada, 296.
Aniline disulphuric acid, 272.
An atomic model for the chemist, 194, 209.
Application of the algebraic aberration equations to optical designs, 77.
Applications of the theory of complete ionisation, The chemical character of strong electrolytes, 41.
Arc spectra of carbon, 169.
Aromatic acid anhydrides (New Patent), 48.
Asbestos paper and asbestos millboard, 282.
Atom, and some material properties and phenomena, The, 289.
Atom of nitrogen, Structure of, 178.
Atomic electricity explained and explained away, 193.
Atomic volume relations in certain isomorphous series, 287.
Atomic volume relations in certain isomorphous series, III, 411.
Austria—Accelerated economic recovery, 70.
Australian Engineer's Account of a Visit to America.
Automatic stamping arrives, 231.
Azo dyes (New Patent), 191.
4-Amino-2-Benzoic acid (New Patent), 111.

BAND spectrum of water vapour, 251.
Base exchange water softening, 365.
Bauxite from Kashmir, India, 237.
Berthelot centenary at Tokyo, 73.
Behaviour of a single crystal of α-iron subjected to successional torsional stresses, 74.
Behaviour of hydrogen and mercury at the electrode surfaces of spectrum tubes, Studies in the, 202.
Bituminous coal, 105.
Boron compounds, 187.
Brief review of the principal base metal and base mineral resources of the Union of South Africa, 51, 67.
Britain behind America, 104.
British Association—next meeting, 407.
British empire in relation to the trade of the world, 269.
British industries fair, 405.

British emigrants and immigrants in 1927, 235.
British Metal Corporation, Ltd., 234.
British overseas trade in the first quarter of 1928, 266.
Budget and smoke abatement, 310.
Budget helping British coal oil, 347.
Building science abstracts, New official publication, 133.

CACOA tannin, 203.

Calcium formaldehyde—sulphoxylate (New Patent), 80.
Calibration and adjustment of Schopper folding tester, 214.
Calendar change suggested by inventor, 87.
Calendar reform, 231.
Canadian chemical industries : their growth and future prosperity, 216.
Canadian chemistry division report, 135.
Canadian electric stations, 250.
Canadian investments abroad, 167.
Canadian match industry—Big amalgamation, 167.
Canadian talc and soapstone industry, 166.
Canadian trade in 1927, 105.
Canada's growing chemical industries, 391.
Canada's record mineral output, 25.
Canonical forms in the theory of asymmetrical optical systems, 76.
Carnegie Institute of Technology, 24.
Carnegie Institute of Technology, 359.
Certain problems in physiology of the cerebral hemispheres, 318.
Chemicals and allied industries in Canada
Chemical constant of hydrogen vapour and the failure of Nernst's heat theorem, 169.
Chemical constitution of selacholeic acid, 72.
Chemical engineer, The, 102.
Chemical fertilisation for Canadian wheat lands, 249.
Chemical industrial conference dinner, 330. in 1926, 330.
Chemical study of low temperature tar, 378.
Chemistry and industry : Conference in London, 311.
Chemistry of the three-carbon system, 285.
China wood oil, 123.
Cinematograph films Act, 216.
Coal age past, Raw, 250.
Coal export figures, 391.
Coal, iron and steel in various countries, 282.
Coal, iron and steel in Europe and the U.S.A., 358.
Coal resources, National survey, [illegible]

Coffee parchment as an adulterant of bran and sharps, 298.
Cohesion and related problems, 317.
Colliery technical investigation, 188.
Colliery £10,000,000 pithead scheme, 26.
Collinsics of minerals, 305, 385.
Colorimetric determination of small quantities of antimony and their separation from tin, 298.
Combination complex salts of bivalent platinum with $\alpha\beta\gamma$-triaminopropane, 153.
Committee of industry and trade, 366.
Composition of the fatty acids present as glycerides in elasmobranch oils, 203.
Concept of mass and the laws of the conservation of matter and energy, 337.
Concrete as a fire-resisting material, 248.
Condensation of nitriles with thioacids, 245.
Constitution of trebenine, 153.
Construction of an interferometer pressure gauge, 75.
Containers for acids, 207.
Co-operative movement in Russia, 7.
Co-partnership principle, 78.
Copper complex salts, 364.
Crystal structure of the Chondrodite series, 9.
Critical absorption photometer for the study of the Compton effect, 379.
Crookes, Sir William as a pioneer of the synthetic nitrogen industry, 249.
Crystals of β-brass, Formation of, 74.
Cyclo telluropentane, 59.
Cytological studies in the viruses of fowl-pox and vaccinia, 186.
Czechoslovak foreign trade in 1927, 121.
1-(2[1]-Carboxyphenyl)-anthraquiones (New Patent), 128.
Czechoslovak trade with England, 180.
Czechoslovak scientists, physicians and engineers, Sixth congress of, 397.

DENSITY and electrical properties of the *system rubber-sulphur, 22.*
Density and electrical properties of the system rubber-sulphur, 22.
Dependence of the photographic action of β-rays on their velocity, 395.
Design and operation of glass furnaces, 91.
Design of coils for the production of strong electric fields, 251.
Detection of fire-damp by flame safety lamps, 375.
Deterioration of lead cable sheathing by cracking, 186.
Determination of butter in margarine, 107.
Determination of carbon dioxide in soils.
Determination of Carvone in dill oil, 108.

Determination of colour-producing constituents of cacao beans, 298.
Determination of e/m, 145, 161.
Determination of small quantities of benzoic acid, 188.
Determination of vanadium in steel, 298.
Development of standardisation and simplification, 180.
Development prospects in exploitation of natural gas, 219.
Development of the heavy chemical industry, 357.
Dielectric constant of liquid bromine, 75.
Dissociation of sodium sulphate decahydrate, 171.
Distribution of intensity in the band spectrum of helium, 202.
Distribution of stress round a circular hole in a plate, 394.
Distribution of ten million trees in Canada, 249.
Durability of iron-containing glasses, 28.

EARLY chemistry in Ireland, 101.

Earth, The, 408.
East London College, 113.
Economy in combustion by air preheating, 149.
Education in industry, 365.
Effects induced by the phenyl group, Part I, 235.
Effect of temperature on the viscosity of neon, 394.
Elastic constants of glass, 383.
Electrical properties of rubber-sulphur compounds, 22.
Electric-reduction of organic substances, 199.
Electric methods of hygrometry, 270.
Electron emission in intense electric fields, 378.
Electron, The, 166.
Embryology of a mysid crustacean, Hemimysis Lamornæ, 122.
Emission of secondary electrons and the excitation of secondary X-rays, 378.
Enzymatic function of mitochondria in the germination of cereals, 44.
Errors of a reflecting prism, 410.
Ethyl motor spirit and lead poison, 156.
Examination of liquorice mass, 316.
Excitation of soft X-rays, 378.
Experiments on diffusion in solid metals, 91.
Experiments with mercury jets and the phenomena exhibited at their impact with steel and glass, 332.
Experimental researches on vegetable assimimilation and respiration, 45.
Experimental study on the combustion of mixtures of hydrogen with air or oxygen in eudiometer, 6.
Explosives in mines and quarries, 377.
Explosives, 52nd report of H.M. inspectors, 392.
Extractions of electrons from cold conductors in intense electric fields, 151.

FARADAY Society meeting at Cambridge, September, 1928, 377.
Filing data in works, 278.
Fire without smoke, 88.
Fishery statistics of Canada, 25.
Flavanthrone derivatives (New Patent), 159.
Foreign exchanges in 1927, 39.
Forthcoming (Government) mining examinations, 158.
Fuel industries and the work of the chemical engineer, 329.
Further radiometric measurements and temperature estimates of the planet Mars, 1926, 37.
Future of synthetic nitrate industry, 359.

HARE, Robert, An early American chemist, 65.
Heat saving in industry, 281.
Heating effects of thorium and radium products, 169.
Hexahydrated double sulphates containing thallium, 201.
Hydrocyanic acid (New Patent), 144.
Hydro-electrical progress in Canada in 1927, 105.
Hydrogenation of certain extended heterogeneous systems, 158.

IONISED hydrogen molecule 169.

Immunological and seralogical studies on the viruses of fowl-pox, 122.
Improved industrial prosperity, 13.
Important uses of carbon dioxide liquid, 24
Indeterminateness of electrical charge, 156.
Industrial reorganisation, 265.
Influences of vortices upon the resistance experienced by solids moving through a liquid, 394.
Inorganic chemistry, mainly metals, 108.
Inspectors of explosives, Report of, 413.
Institute of Chemistry January pass list, 55.
Institute of chemistry, annual meeting, 147.
Institute of Chemistry, April examination pass list, 334.
Institution of Gas Engineers, 297.

Institute of Metals 20th annual meeting, 80.
Institution of Mining Engineers, annual meeting, 27.
Institute of Metals, 120.
Instance of multiplication by proportion, 254.
Interchange of electricity between thunder-clouds and earth, 89.
International conference on bituminous coal, 265.
International congress of tropical medicine, 232.
International trade conditions, 12.
Investigation into the analytical chemistry of tantalum, niobium, etc., 315.
Investigation into the beam from a standard lighthouse lens, 108, 155.
Investigations into the analytical chemistry of tantalum, niobium, etc., 107.

KINETICS *of the combination of hydrogen* and oxygen, 152.
Knocking, Problem of, 149.

LAWS of aromatic substitution, 236.
Lead-tin system of alloys re-examined by an electrical resistance method, 100.
Lenses, Note on the uses of in series for sight testing, 411.
Light of the night sky, 252.
Liver fluke disease in Australia, 277, 291.
Livingstone College, 408.
Locust kernel gum and oil, 315.
London builders and clear air campaign, 328.
Lower carboniferous rocks of the Menaian *region, 28.*
Low temperature carbonisation, 281.

MAJOR intrusions of South-Eastern Iceland, 237.
Manganese deposit of Pleistocene age in Idaho, 167.
Maxima on current voltage, 125.
Measurement of specific heat of aniline with temperature, 90.
Metallurgy, Scientific methods in, 177.
Metals and minerals of South Africa, 84.
Method for determination of the probable durability of tank blocks, 286.
Method of determining the state of polarity of downcoming wireless waves, 90.
Miller's experiments and the constitution of matter, Part V., 129.
Mobile-anion tautomerism, 186.
Mobility of ions, 317.
Minimum proper time and its application to (1) the number of the chemical elements, and (2) some uncertain relations, 152.
Molecular displacements in diffusing gas mixtures, 379.
Molecular conductivities and extinction coefficients of derivatives of cyclotelluropentane, 380.
Motor spirit from British coal, 118.
Municipal offensive urged by national conference on smoke abatement, 215.
Myothermic apparatus, 409.

NETHERLANDS East India trade review, 1927.
Neocyanine, 382.
New abstract service, 182.
New colliery £10,000,000 pithead scheme, 26.
New method for the determination of small amounts of lead, 107.
New mineral names, Eleventh list of, 411.
New precipitation method of determining vanadium and its application to steel analysis, 315.
377.
Nitrogen, Structure of an atom of, VI., 49.
New short flame pulverised fuel burner, 3.
New synthetic motor fuel in Germany, 351.
New world finance combine, 265.
Nitrogen, Structure of an atom of, 178.
Nodal cubic surfaces and the surface from which they are derived, 378.
North Chinese species of the genus Phlebotomus, 184.
Northeast coast exhibition of science and art, May-October, 1929, 201.
Nova Pictoris, 276.
Numerical relationship of proportions and associated figures, 301.

OBSERVATIONS on the passivity of metals, 187.
Oil from coal, 200.
Oil well and later developments at Hardstoft, Derbyshire, 260.
Ontario nickel-copper industry, 375.
On line-integrals of the diurnal magnetic variations, 380.
Ontario Government to set up research foundation, 167.
Organic acids, 351.
Overpotential in metallic cathodes, 404.

PART played by British workers in the application of fixed nitrogen to the soil, 389.
Periodic table of the planets, 387.
Petrol from coal, 344.
Phenomena occurring in condensation of atomic streams on surfaces, 394.
Phosphate rock in the Three Forks, Yellowstone Park region, Mon., 268.
Phosphoric acid (New Patent), 64.
Photoelectric theory of sparking potentials, 8.
Place names of mineral localities in Central Europe, 411.
Plant research laboratory, Alberta, 328.
Polution of tidal and non-tidal rivers, 408.
Portland cement selling and distribution company, 103.
Potarite, A new mineral discovered by the late Sir John Harrison in British Guiana, 75.
Potash salts in Canada, Discovery of, 393.
Potassium-ammonium and other phosphates, 384.
Potassium carbonate and other salts, 303.
Pre-Cambrian complex and associated rocks (Carmarthenshire), 285.
Preparation and properties of selenophen, 123.
Preparation of catalyser by the electrolytic corrosion of nickel, 345.
Primordial coefficients of asymmetrical lenses, 411.
Problem of keeping warm, 72.
Problem of knocking, 149.
Production of silk by species of the genus *Hilara* Meig, 184.
Progress in the metal industries, 328.
Properties of conjugated compounds, 59.
Properties of conjugated compounds, 153.
Principal base metal resources of South Africa, 51.
Pulverised fuel progress, 103.
Pulverised fuel, 347.

QUANTUM theory of the electron, 152.

RAMSEY memorial laboratory of chemical engineering, 215.
Raw coal age past, 250.
Recovery of debts in Turkey, 285.
Recovery of heat production in oxygen after a series of muscle twitches, 410.
Re-determination of velocities of particles from radium C, thorium C and C′, 221.
Re-excavated cretaceous valley on the Mongolian border, 381.
Reid process, The, 104.
Researches on sulphonated oils, 102.
Russia, Co-operative movement in, 7.
Restored electron theory of metals and thermionic formulæ, 152.
Right use of coal, 398.
Rigidity and other anomalies in colloidal solutions, 9.
Rise of the new quantum mechanics, 353, 369.
Role of oxidation in maintaining the dynamic equilibrium of the muscle cell, 409.
Rotation of the orbits of six planets and cognate phenomena, 225.
Royal Institute of Public Health, Forthcoming congress in Dublin, 58.
Royal Institution new officials, 286.
Royal Society secretary knighted, 366.
Royal Society of Arts, Industrial designs, 1928, 55.

SAFETY in Mines Research Board reports, 105.
Saha theory and the conductivity of flames containing alkali metal vapours, 220.
Sanitation of the dead, 251.
Scattering of light by individual particles in smoke, 75.
Science and building, 264.
Science helping housewives, 326.
Science training, 321.
Scientific method of training in schools and colleges, 241.
Scientific research as applied to industry, 326.
Scientific study of the human factor, 215.
Scrap iron and steel from France, 157.
Seasonal variations in the composition of the latex of Hevea Brasilensis, 108.
Second international conference of bituminous coal, 71.
Selenium tetrafluoride, 236.
Separation of lead tetra-ethyl from solution in petroleum spirit, 315.
Series of Bessel functions connected with lattice-points of an n-dimensional ellipsoid, 379.
Sheffield medical officer on the smoke nuisance, 216.
Siamese foreign trade, 288.
Simple and accurate constant volume pyrometer, 75.
Sir John Cass Technical Institute, 40.
Sir Oliver Lodge on the revelation in physics, 267.
Slag, coke and breeze clinker, 105.
Smith, Death of Professor Edgar, 395.
Smokeless fuel, 188.
Society for co-operation of scientific and technical workers in the Socialist construction of Russia, 8.

Sodium pyrophosphates, 97.
Sodium sulphate decahydrate, Dissociation of, 171.
Sodium thio-pyrophosphates, 113.
Solid solution and compound formation, Note on, 401.
Some applications of the theory of complete ionisation, 41.
Some attempts to separate the isotopes of magnesium, 295.
Some cases of instability of fluids, 152.
Some electrical properties of rubber-sulphur compounds, 22.
Some methods of estimating the intensity of spectral lines, 269.
Some new facts arising from a study of the casing of colourless by coloured glass, 314.
Some Physico-chemical properties of stannous chloride, 243.
Spectrum of douhly ionised oxygen, 9.
Spectrum of fluorine, 9.
Speiss and metals of the platinum group, 283.
Spontaneous resolution of externally compensated mixtures, 123.
Standard atmosphere, 282.
Statistical abstract for the United Kingdom, 1912 to 1926, 331.
Statistical experiments on the motion of electrons in gases, 250.
Steam accumulator developments, 229.
Stellar energy, relativity, gravity, æther, photo-electric effect, 1, 33.
Stereoscope, 221.
Structure of the band spectrum of helium, 220.
Structure of symbols, 17.
Studies in the behaviour of nitrogen, 202.
Studies in the microchemistry of the cell, 136.
Studies of valency, 380.
Study of a fundamental reaction in glass making, 286.
Study of specific resistance of bismuth crystals, its change in strong magnetic fields, and *some allied problems*, *396*.
Successtion and structure of the Borrowdale series in Trousbeck, Kentmere, etc., 383.
Succession and structure of the Borrowdale volcanic series in Troutbeck (Westmoreland), 297.
Sulphuric acid (New Patent), 287.
Sulphuric acid (New Patent), 223.
Sulphuric action on copper, Action of, 81.
Sun or moon for workers, 285.
Swan band spectrum of carbon, 137.
Sweden's commercial progress, 233.
Synthesis of meso-alkyl and meso-aryl anthracene derivatives, 91.
Syntheses of cyclic compounds, *59*.
Synthetic nitrate, 299.
Synthetic resins (New Patent), 176.

TECHNICAL College, Glasgow, 120.

Theory of strong electrolytes, 317.
Theory of aplanatic surfaces, 411.
Thermal conductivities of oxygen ond nitrogen, 90.
Thermal expansion of beryllium and aluminium-beryllium alloys, 389.
Toric lenses, 76.
Trade catalogues, 135.
Trade under modern conditions, 182.
Trichromatic colorimeter with special primaries, 410.
Triplet children in Great Britain and Ireland, 45.
Tube still distillation, 361.

UNEXPLORED branches of industry in *Czecho-slovakia*, 374.
United States of America, National wealth and industrial conditions, 56.
United States trade conditions, 25, 119.
Unsaturated hydrocarbons in the gases from the carbonisation of coal, 345.
Unventilated geysers, 151.
Ultra-violet ray transmission of colourless bottle glass, 170.
Use and testing of sphygmomanometers, 340.

WASTE gases of the Ruhr to be utilised, 281.
Water power and industries in Canada, 230.
Water purification, 389.
Wave equation of the electron, 379.
Wholesale prices in France, Belgium, Germany, and Italy, 7.
Wholesale *prices* in 1927, *55*.
Wholesale prices in France, Germany and Italy in November, 1927, 70.
Wholesale prices in February, 200.
Wholesale prices in *April*, 348.
Wider aspects of cosmogony, 253.
Wonderful scope for research and technical chemist, 183.
World's engineering congress at Tokyo, 78.
World's largest high-pressure steam plant, 70.

X-RAY study of some simple derivatives of ethane, Part I, 90.
X-ray study of some simple derivatives of ethane, Part I, 90.

YEARLY variations in plague in India in relation to climate, 193.

AUTHORS.

Adam, W.B., M.A., A.I.C. :
Determination of the Colour-producing Constituents of the Cacao Bean, 298.
Appleton, E. V., and Ratcliffe, J. A. :
Method of Determining the State of Polarity of Downcoming Wireless Waves, 90.
Anderson, Annie I., B.Sc. :
The Dielectric Constant of Liquid Bromine, 75.
Anderson, L., and Hill, D. W. :
A Cause of Spontaneous Resolution of Externally Compensated Mixtures, 123.
Ashworth, F., and Burkhardt, G. N. :
Effects Induced by the Phenyl Group, 235.
Auld, Lieut.-Col., S. J. M., O.B.E., M.C., D.Sc. :
Development of problems in the Exploitation of Natural Gas, 219.
A Well-Known Engineer :
Base Exchange Water Softening, 365.

Baker, Prof. Will. C. :
Experiments with Mercury Jets and the Phenomena Exhibited at their Impact with Steel and Glass, 332.
Barbour, Prof. George Brown, M.A., Ph.D. :
A Re-excavated Cretaceous Valley on the Mongolian Border, 381.
Bell, G. Eric, B.Sc. :
A Valve-Maintained High-Frequency Induction Furnace, 333.
Beckinsale, S., B.Sc., A.I.C., and Waterhouse, H. :
Deterioration of Lead Cable Sheathing by Cracking, and its Prevention, 186.
Biggs, G. H. :
A Redetermination of the Velocities of Particles from Radium C, Thorium C and C', 221.
Black, J. W., B.Sc. :
Effects of Other Reducing Substances on the Determination of SO_2, 189.
Bligh, N. M., A.R.C.Sc., A.I.C. :
The Rise of the New Quantum Mechanics, 353, 369.
Bowwater, E. J. C., B.Sc. :
Method of Determination of the Probable Durability of Tank Blocks, 236.
Brickly, W. G. :
The Influences of Vortices upon the Resistance Experienced by Solids Moving Through Liquids, 394.
The Distribution of Stress Round a Circular Hole in a Plate, 394.
Briscoe, H. V. A., and Peel, J. B. :
Preparation and Properties of Selenophen, 123.
Brombacher, W. G. :
Standard Atmosphere, 282.
Bronsted, Prof. J. N. :
"Activity," 317.
Buisson, Arthur :
Antimony in Canada, 296.
Burbridge, P. W., M.Sc., B.A. :
Electrical Methods of Hygrometry, 270.
Burnett, E. de B., and Cook, J. W. :
The Synthesis of Meso-Alkyl and Meso-Aryl Anthracene Derivatives, 91.
Burton, H., and Ingold, C. K. :
Mobile-Anion Tautomerism, 18[illegible].

Cargill, Hilda Kathleen, M.Sc., Hawkes, Leonard, D.Sc., and Ledeboer, Julia Augusta, M.Sc. :
The Major Intrusions of Southern Iceland, 237.
Carpenter, H. C. H., M.A., F.R.S. :
Alloy Steels, Their Manufacture, Property and Uses, 307, 324.
Challenger, F., and Peters, A. T. :
The Nitration of Aromatic Thiocyanates and Selenocyanates, 235.
Chapman, S., F.R.S. :
The Molecular Displacements in Diffusing Gas Mixtures, 379.
Charlesworth, Prof. John Kaye, D.Sc., Ph.D. :
The Glacial Retreat from Central and Southern Ireland, 124.
Childs, W. H. J. :
The Distribution of Intensity in the Band Spectrum of Helium : The Band λ4650, 202.
Some Methods of Estimating the Intensity of Spectral lines, 269.
Chubb, Lawrence John, B.Sc. :
The Geology of the Marquesas Islands, 299, 384.
Clarke, S. G., B.Sc., A.I.C. :
Colorimetric Determination of Small Quantities of Antimony in Tin, 298.
Coblentz, W. D., and Lampland, C. O. :
Further Radiometric Measurements and Temperature Estimates of the Planet Mars, 36.
Cockett, J. D. :
On Phenomena Occuring in the Condensation of Atomic Streams on Surfaces, 394.
Cockcroft, J. D. :
The Design of Coils for the Production of Strong Magnetic Fields, 251.
Cocks, L. V., A.I.C., and Nightingale, E :
The Determination of Butter in Margarine, 107.
Collins, Hawksworth, B.A. (Camb.) :
Structure of an Atom of Nitrogen, VI., 49; VII, 178.
The Collinsics of Minerals, 305, 385.

Collingridge, H. :
On the Determination of Axial Angles and Crystal-forms from Observations by the Beck Method, 412.
Coste, J. H. F.I.C., F.Inst.,P. :
The Pollution of Tidal and Non-Tidal Rivers, 403.
Coudit, J. T., Finch, E. H., and Pardee, J. T. :
Phosphate Rock in the Three Forks, Yellowstone Park Region, Mont., 263.
Curtis, H. L., McPherson, H. T., and Scott, A. H. :
Density and Electric Properties of the System Rubber-Sulphur, 22.
Some Electrical Properties of Rubber-Sulphur Compounds, 22.
Curtis, Harvey L., and Moon, Charles :
Absolute Measurement of Capacitance by Maxwell's Method, 297.
Curtis, W. E. :
Structure of the Band Spectrum of Helium, 220.

Darwin, C. G., F.R.S. :
The Wave Equation of the Electron, 379.
Davidson, J. H., M.Sc., F.I.C., and Dimbleby, Miss V., M.Sc. :
Analysis of Opal Glasses, 27.
Dingle, H. :
The Spectrum of Fluorine, 9.
Dirac, P. A. M. :
The Quantum Theory of the Electron, 152.
Druce, J. G. F., M.Sc., (Lond.). :
The Action of Sulphuric Acid on Copper, 81.
Duckham, Sir Arthur, K.C.B. :
Fuel Industries and the Work of the Chemical Engineer, 329.

Edmonds, C. H. S., A.M.S.c.Mech.E. :
Tube Still Distillation, 361.
Edwards, R. S. :
The Effect of Temperature on the Viscosity of Neon, 394.
Ellis, C. D., and Aston, G. H. :
The Dependence of Photographic Action of β-Rays on their Velocity, 395.
Ellsworth, Dr. H. V. :
A Simple and Accurate Constant-Value Pyrometer, 75.
Eltriggham, H. :
On the Production of Silk by Species of the Genus *Hilara* Meig, 184.
English, S., D.Sc., F.I.C., Turner, Prof. W. E. S., and Winks, W. M.Sc.Tech. :
Some New Facts Arising from a Study of the Casing of Colourless by Coloured Glass, 314.

Emelanova, N. V., and Heyrovsky, J. :
Maxima on Current Voltage Curves, 125.
Etheridge, A. T., Ph.D., F.I.C. :
Determination of Vanadium in Steel, 298.
Etridge, J. J., and Sugden, S. :
The Parachor and Chemical Constitution (Boron Compounds), 189.
Evans, B. S., Ph.D., F.I.C. :
A New Method for the Separation and Determination of Small Amounts of Lead, 107.
Evans, B. S., and Clarke, S. G. :
New Precipitation Method of Determining Vanadium and its Application to Steel Analysis, 315.
Evans, John, F.I.C., and Wallis, T. E. :
Coffee Parchment as an Adulterant of Bran and Sharps, 298.

Farmer, E. H., and Evans, J. T. :
The Hydrogenation of Certain Extended Heterogeneous Systems, 153.
Farmer, E. H., Lawrence, C. D., and Thorpe, J. F. :
Properties of Conjugated Compounds, 59.
Findlay, G. M. :
Imunological and Seralogical Studies on Viruses of Fowl Pox and Vaccinia, 122.
Fink, Colin G., and Mantell, C. L. :
Preparation of Pure Stannous Oxide, 243.
Fisher, R. A. :
Triplet Children in Great Britain and Ireland, 45.
Flint, H. T., and Richardson, O. W., F.R.S. :
On a Minimum Proper Time, and (1) Its Application to the number of the Chemical Elements, and (2) Some Uncertain Relations, 152.
Flursheim, B., and Holmes, E. L. :
The Laws of Aromatic Substitution, 286.
Fowler, R. H., F.R.S. :
The Chemical Constant of Hydrogen Vapour and the Failure of Nernst's Theorem, 169.
The Restored Electron Theory of Metals and Thermionic Formulæ, 152.
Fowler, R. H., F.R.S., and Nordheim, L. :
Electron Emission in Intense Electric Fields, 378.
Fowler, A., F.R.S., and Selwyn, E. W. H. :
The Arc Spectrum of Carbon, 169.
Fowler, A., F.R.S. :
The Spectrum of Doubly Ionised Oxygen, 9.
Fowles, G. M.Sc., A.I.C. :
The Action of Copper on Sulphuric Acid,

Gardner, I. C. :
Application of the Algebraic Aberration Equation to Optical Design, 77.
Gilbert, F. L., and Lowry, T. M. :
Studies of Valency, 380.
Gough, H. :
The Behaviour of a Single Crystal of α-Iron Subjected to Alternating Torsional Stresses, 74.
Grant, Julius, M.Sc., A.I.C. :
Overpotential in Metallic Cathodes : Silver in Neutral and Alkaline Solutions, 404.
Greenly, Dr. Edward, V. P. G. S. :
Lower Carboniferous Rocks of the Menaian Region of Carnarvonshire, 28.
Gregory, F. G. :
The Differential Effect of the Ions of Three-Salt Solutions in the Growth of Potato Plants in Sand Culture, 45.
Gregory, H., and Marshall, S. :
The Thermal Conductivities of Oxygen and Nitrogen, 90.
Gulland, J. M., and Virden, C. J. :
The Constitution of Trebenine, 153.

Hackh, Ingo W. D. :
Structure of Symbols, 17.
Hallimond, A. F. : On the Atomic Volume Relations in Certain Isomorphous Series, 237.
On the Atomic Volume Relations in Certain Isomorphous Series III, 411.
Hallsom, H. E. :
Sodium Thio-Pyrophosphates, 113.
Hamer, F. M. :
Neocyanine, 332.
Hampton, W. M., Uh.D., B.Sc. :
An Investigation into the Beam from a Standard Lighthouse, 158.
Hatschek, Emil, F.Inst.P. :
Rigidity and other Anomalies in Colloidal Solutions, 9.
Hedges, E. S. :
Observations on the Passivity of Metals, 187.
Henry, T. A., and Sharp, T. M. :
The Alkaloids of Some Indian Aconites, 91.
Hewett, D. F. :
A Manganese Deposit of Pleistocene Age in Idaho, 167.
Heywood, H. :
Pulverised Fuel, 347.
Hidnett, Peter, and Sweeney, W. T. :
Thermal Expansion of Beryllium and Aluminium-Beryllium Alloys, 389.
Hilditch, T. P. :
Composition of the Fatty Acids Present in Glycerides in Elasmobranch Oils, 203.

Hill, A. V., F.R.S. :
The Air Resistance to a Runner, 122.
Myothermic Apparatus, 409.
The Role of Oxidation in Maintaining the Dynamic Equilibrium of Muscle Cell, 409.
Heat Production in Oxygen after a Series of Muscle Twitches, 410.
Hinshelwood, C. N., and Thompson, H. W. :
The Kinetics of the Combination of Hydrogen and Oxygen, 152.
Holmes, Prof. A., and Harwood, H. F. :
On the Age and Composition of the Whin Sill (N. of England), 287.
Horning, E. S., and Petrie, E. H. K. :
Enzymatic Function of Mitochondria in the Germination of Cereals, 44.
Houseman, P., Ph.D., F.I.C. :
The Examination of Liquorice Mass, 316.
Houston, Sir Alexander, K.B.E. :
Water Purification, 389.
Howarth, J. T., M.Sc., and Turner, Prof. W. E. S. :
Study of a Fundamental Reaction in Glassmaking, 236.

Iki, Sadao :
On the Preparation of Catalyser by the Electrolytic Corrosion of Nickel, 345.
Isakawa. Seiichi :
Condensation of Nitriles with Thioacids, 245.

Jack, D., The Band Spectrum of Water Vapour, 251.
Jeans, Dr. J. H. :
The Wider Aspects of Cosmogony, 253.
Jeffreys, H., F.R.S. :
Some Cases of Instability of Fluids, 152.
Jeffery, F. H. :
Lead-Tin System of Alloys Re-examined by an Electrical Resistance Method, 100.
Jenkin, J. W., and Desch, C. H. :
Some Experiments in Diffusion in Solid Metals, 91.
Jensen, H. R., M.Sc. :
Cacoa Tannin, 203.
Rapid Estimation of Sulphites, 139.
Barium Sulphate Losses in Gravimetric Estimation, 180.
Johnson, M. C. :
Studies in the Behaviour of Hydrogen and Mercury at the Electrode Surfaces of Spectrum Tubes, 202.
Jones, Osman, F.I.C. :
Determination of Sulphur Dioxide, 180.
Jourdain, C. J. N. :
A Brief Review of the Principal Base Metal Resources of the Union of South Africa, 51, 65, 84.

Kapitza, P.:
The Study of the Specific Resistance of Bismuth Crystals, its Change in Strong Magnetic Fields, and Some Allied Problems, I and II, 395.
Kingslake, Dr. R., M.Sc., A.R.C.S.:
The Absolute Hartmann Test, 155.
Koster, M.:
Education and Industry, 365.
Kreis, E. S., B.Sc., A.R.C.S., A.I.C.:
Filing Data in the Works, 273.

Lang, H. R.:
Measurement of Specific Heat of Aniline with Temperature, 90.
Langworthy, Florence:
An Atomic Model for the Chemist, VIII, 194, 209.
Lees, George Martin, M.C., D.F.C.:
Geology of South-Eastern Arabia, 75.
Lehrman, Alexander:
Note on Solid Solution and Compound Formation, 401.
Linfoot, E. H.:
On the Law of Large Numbers, 379.
Lodge, Sir Oliver:
On the Revolution in Physics, 267.
Loring, F. H.:
Stellar Energy, Relativity, Gravity, Æther, Photo-Electric Effect, 1, 33.
Determination of e/m, 145, 161.
The Rotations of the Orbits of Six Planets, and Cognate Phenomena, 215.
Nova Pictoris, 276.
A Periodic Table of the Planets, 387.
Lowry, T. M., MacConkey, C. A. H., and Burgess, H.:
The Absorption Spectra of Phototropic Compounds, 186.
Lowry, Prof. T. M., F.R.S.:
Some Applications of the Theory of Complete Ionisation. The Chemical Character of Strong Electrolytes, 41.
Ludford, R. J.:
Studies in the Microchemistry of the Cell, 136.
Cytological Studies on the Viruses of Fowl-Pox and Vaccinia, 186.
Lunnon, R. G.:
Fluid Resistance to Moving Spheres, 220.

Mackinder, Sir Halford:
The British Empire in Relation to the Geography of the World, 269.
Madgin, W. M., Peel, J. B., and Briscoe, H. V. A.:
Cryoscopic Evidence of Compound Formation in Mixtures of Organic Liquids, 123.
Manley, J. J.:
On the Construction and Standardisation of an Interferometer Pressure Gauge, 75.
Mann, F. G.:
The Complex Salts of Bivalent Platinum with αβγ-triaminopropane Trihydrochlorite, 153.
Manning, A. B., Ph.D., M.Sc., D.I.C., and Others:
The Unsaturated Hydrocarbons in the Gases from the Carbonisation of Coal, 345.
Manton, S. M.:
On the Embroyology of a Mysil Crustacean, 122.
Maskell, E. J.:
Experimental Researches on Vegetable Assimilation and Respiration, 45.
Mason, H. M., M.Sc.:
Oxidation of Sulphites by Air, 139.
Note on the Titration of Dilute Sulphite Solutions, 139.
Matley, Charles, Alfred, D.Sc., F.G.S.:
The Pre-Cambrian Complex and Associated Rocks of South-Western Lleyn (Carnarvonshire), 151.
The Pre-Cambrian and Associated Rocks of S.W. Lleyn (Carm.), 285.
McMaster, L., and Ahmann, F. F.:
Action of Thionyl Chloride on Organic Acids, 196.
Meggers, W. F., and Walters, Junr., F. M.:
Absorption Spectra of Iron, Cobalt and Nickel, 28.
Mishimura, Tsunekichi:
Some Attempts to Separate the Isotopes of Magnesium, 294.
Mitchell, George Hoole, Ph.D., M.Sc., F.G.S.:
The Succession and Structure of the Borrowdale Volcanic Series, 298.
The Succession and Structure of the Borrowdale Volcanic Series, 285.
Mond, Sir Alfred:
Scientific Research as Applied to Industry, 326.
Morgan, G. T., and Burges, H.:
Cyclo Telluropentane, 59.
Morgan, Prof. G. T., F.R.S.:
A Chemical Study of Low Temperature Tar, 373.
Murray, R. M.:
Account of Visit to America, 117, 180.
Morrell, H. S., and Marks, S.:
China Wood Oil, The Oxidation of β-elæostearic Glyceride, 123.

Nicholls, A. B., Ph.D., M.Sc., D.I.C., and Others :
Determination of Small Bands of Benzoic Acid, 188.

Paling, W., M.P., and Williams, Tom, M.P. :
The Right Use of Coal, 398.
Partington, Prof. J. R., and Mr. H. E. Wallson :
Sodium Pyrophosphates, 97.
Paton, W. S., and Hindle, E. :
North Chinese Species of the Genus *Phlebotomus*, 184.
Perman, Edgar Philip, and Urry, William Donald :
The Dissociation of Sodium Sulphate Decarhydrate, 171.
Pollitt, L.-Col. C. P., D.S.O. :
Developments in the Heavy Chemical Industry, 357.
Pretty, W. E., A.R.C.S., B.Sc. :
Swan Band Spectrum of Carbon, 187.
Elastic Constants of Glass, 388.
Price, A. T., and S. Chapman, F.R.S. :
On Line Integrals of the Diurnal Magnetic Variations, 380.
Prideaux, E.B. R., and Cox, C. B. :
On Selenium Tetrafluoride, 236.
Pugh, Prof. Wm. J., O.B.E., B.A. :
Geology of the District of Dinas Mawddwy, 187.

Rae, Norman, M.A., F.I.C. :
Seasonal Variations in the Composition of the Latex of Hevea Brasilensis, 108. 108.
Rao, Dr. T. V. M. :
On Bauxite from Kashmir, India, 287.
Ramon, C. V., F.R.S., and Sogani, C. M. :
A Critical Absorption Photometer for the Study of the Compton Effect, 379.
Reilly, R., D.Sc., F.I.C., & Drumm, P. J. :
The Determination of Carvone in Dill Oil, 99.
Richardson, O. W., F.R.S. :
On the Extraction of Electrons from Cold Conductors in Intense Electric Fields, 151.
The Emmission of Secondary Electrons and the Excitation of Soft X-Rays, 378.
Riad, A., B.Sc., Ph.D. :
Determination of Carbon Dioxide in Soils, 298.
Richardson, E. G., B.A., M.Sc., Ph.D. :
Amplitude of Sound Waves in Resonators, 368.
Rogers, Sir Leonard, F.R.S. :
The Yearly Variation in Plague in India, 183.
Robertson, J. M. :
An X-Ray Investigation of the Structure of some Naphthalene Derivatives, 379.
Rosenhain, Dr. :
Presidential Address at the Institute of Metals, 185.
Ross, J. Clunies, B.V.Sc. :
Liver Fluke in Australia, 277, 291.
Rusden, H., and Henderson, J. :
Speiss and the Metals of the Platinum Group, 288.
Russell, Sir John, D.Sc., F.R.S. :
The Part Played by British Workers in the Application of Fixed Nitrogen to the Soil, 339.

Sachoschansky, A., B.Sc. :
Multiplication by Proportion, 254.
Saxon, Robert, B.Sc., F.C.S. :
Scientific Teaching in Schools and Colleges, 241, 321.
Schoeller, W. R., Ph.D., and Waterhouse, E. F. :
Investigation into the Analytical Chemistry of Tantalum, Niobium, etc., 315.
Schoeller, W. R., Ph.D., and Powell, A. R. :
The Separation of Silica from the Earth Acids, 107.
Schofield, M., M.A., B.Sc., A.I.C. :
Adsorbent Materials of Use in Chemical Industry, 372.
Schonland, B. F. J. :
The Interchange of Electricity Between Thunderclouds and the Earth, 89.
Shikata, Dr. M. :
The Electro-Reduction of Organic Acids, 199.
Shikata, Masuzo :
On Copper Complex Salts, 364.
Slavik, Prof F., and Spencer, Dr. L. J. :
Place-Names of Mineral Localities in Europe, 411.
Smith, Edgar F. :
Glance at the Early Organic Chemistry of America, 4.
Robert Hare, An Early American Chemist, 65.
Smith, T. M.A. :
The Toric Lenses, 76.
Canonical Forms in the Theory of Asymmetrical Optical Systems, 76.
Smith, T., M.A., F.Inst.P. :
The Theory of Aplanatic Surfaces, 410.
The Primordial Coefficients of Asymmetrical Lenses, 411.
Note on the Uses of Lenses in Series for Sight Testing, 411.

Smith, W. Campbell :
Optical Orientation of Labradorite from County Down, Ireland, 75.
Snow, Chester :
Indeterminateness of Electrical Discharge, 156.
Spencer, Dr. L. J. :
Portarite : A New Mineral Discovered by the late Sir John Harrison in British Guiana, 75.
Starkin, David, M.Sc., and Turner, Prof. W. E. S. :
Note on Ultra-Violet Ray Transmission of Colourless Bottleglass, 170.
Strachan, J. T., A.I.C., F.C.I.C. :
Activated Carbon : Some Industrial Applications, 212.

Taketomi, Noboru :
Adsorption of Sugars by Animal Charcoal and Decolorising Carbons, 38.
Taylor, G. I., F.R.S. :
The Formation of Crystals of β-Brass, 74.
Taylor, W. H., and West, J. :
The Crystal Structure of the Chondrodite Series, 9.
Taylor, J. :
On a Photoelectric Theory of Sparking Potentials, 8.
Terada, Horahiko ; Yumoto, Kiyohiko ; and Nakaya, Ukitirô :
Experimental Study on the Combustion of Mixtures of Hydrogen with Air, 6.
Thomson, R. T., F.I.C. :
Behaviour of Indicators in the Titration of Ammonia, Sodium, etc., 203.
Timms, G. :
The Nodal Cubic Surfaces and the Surface from which they are Derived by Projection, 378.
Tombrock, Dr. W. :
Miller's Experiments and the Origin of Matter, 129.
Atomic Electricity Explained and Explained away, 193.
The Atom and Some General Material Properties and Phenomena, 289.
The Concept of Mass and the Laws of the Conservation of Matter and of Energy, 337.
Toms, F. W., F.I.C., and Money, C. P., B.Sc., A.I.C. :
The Separation of Lead Tetra-Ethyl from Solution in Petroleum Spirit, 315.
Tutton, A. E. H., F.R.S. :
The Hexahydrated Double Sulphates Containing Thallium, 201.
Hydrated Double Selenates Containing Thallium, 2[illegible]
Tyrrell, George Walter, A.R.C.Sc., Ph.D., F.R.S.E., F.G.S. :
The Analcite-Syenites and Associated Rocks of Ayrshire, 349.

Vogel, I. :
Syntheses of Cyclic Compounds, 59.

Wade, Arthur, D.Sc., A.R.C.Sc., etc. :
The Oil Well and Later Developments at Hardstoft, Derbyshire, 260.
Walmsley, H. P. :
The Scattering of Light by Individual Particles in Smokes, 75.
Waterman, H. I., and Groot, J. :
Action of Nitrous Acid on Wool Fibre, 60.
Watson, S. W., and Henderson, M. C. :
Heating Effects of Thorium and Radium Products, 169.
Well-Known Engineer :
New Short Flame Pulverised Fuel Burner, 8.
Scientific Methods in Metallurgy, 177.
Steam Accumulator Developments, 229.
Williams, A. L., A.I.C. :
Locust Kernel and Gum Oil, 315.
Williams, Prof. E. C. :
The Chemical Engineer, 102.
Wilson, A. H. :
The Ionised Hydrogen Molecule, 169.
A Generalised Spheroidal Wave Equation, 169.
Wilson, H. A., F.R.S. :
The Saha Theory and the Conductivity of Flames Containing Alkali Metal Vapours, 220.
Wilson, J. L., Eaton, H. N., and Henrickson, H. B. :
Use and Testing of Sphygmomanometers, 340.
Wilton, J. R. :
A Series of Bessel Functions Connected with the Lattice-Points of an n-dimensional Ellipsoid, 379.
Winokuti, Kinziro :
Researches on Sulphonated Oils, 102.
Wright, W. D., A.R.C.S. :
A Trichromatic Colorimeter, 410.
Wynn, Dr. Fred E. :
Smoke Nuisance, 216.

Yardley, K. :
An X-Ray Study of S[illegible] Deriva-tives of Ethane, 90.

SOCIETIES.

Chemical Society, 91, 123, 285, 332, 380.
Chemical Society of Japan, 29, 316.
Geological Society, 28, 75, 124, 137, 173, 208, 237, 331.
Faraday Society, 41, 125, 171, 317, 377.
Geological Society, 285, 298, 333, 349.
Institute of Chemistry, 334.
Institute of Metals, 106, 120, 172, 222, 350.
Institution of Petroleum Technologists, 219.
Institution of Petroleum Technologists, 260, 361.
Institution of Electrical Engineers, 266.
Mineralogical Society, 75, 237, 411.
Optical Society, 108, 221, 364.
Physical Society, 75, 137, 269, 332, 363, 381.
Royal Agricultural Society, 208, 316, 412.
Royal Institution, 100, 120, 296.
Royal Society, 8, 44, 59, 74, 89, 122, 136, 169, 201, 220, 251, 313, 349, 360, 378, 394, 409.
Royal Society of Arts, 256, 307, 324.
Society of Glass Technology, 27, 91, 170, 236, 314.
Society of Public Analysts, 107, 138, 202, 297, 315.
The Geographical Association, 269.

CORRESPONDENCE.

An Instance of Multiplication by Proportion, by A. *Sachoschansky*, B.Sc., 254.
Why Wait for New Smoke Laws? By S. G. Moore, M.D.,
Numerical Relationship of Proportion and Associated Figures, by A. Sachoschansky, B.Sc., 301.
Sun or Moon for Workers, by Dr. C. W. Saleeby, M.D., 285.

BOOKS.

A Comprehensive Study of Starch Chemistry, 318.
Acetate Silk and its Dyes, 62.
Alchemical Researches, 60.
American Annual of Photography, 126.
An Illustrated Handbook of the British Sphagna, 46.
Annual Survey of American Chemistry, 62.
Breeding for Milk, 156.
Bulletin of the Bureau of Bio-Technology, 414.
Creatine and Creatinine, 254.
Coloured Thinking, and other Studies, 222.
Chemical Encyclopædia, 190
Commonwealth of Australia, Scientific and Industrial Research Report, 140.
Chemistry of Water and Sewage Treatment, 93.
Die Kolloytischen Wirkungen der Lebendigen Substanz, 61.
Die Bestimmung der wasserstoffionenkonzentration von Flussigkeiten, 29.
Die Fabrikation der Alkaloide, 29.
Das Gesetz der Chemischen Massenwirkung, 61.
Directors of Papermakers, 206.
Dizionario di Synonymi e Composti Chimici, 318.
Fortschritte in der Kali-Industrie, 29.
Fundamentals of Dairy Science, 206.
General Science, 139.
Indian Alchemy, 30.
Inorganic Chemistry, Mainly Metals, 93.
International Year Book of Agriculture, 108.
Leybuch der Cellulosechemie, 46.
Lephuch der Thermostatik, 61.
Le Grandi Industrie Chimiche, 318.
L'Industrio Chimico- Metallurgica, 318.
La Fabrication Chimique de L'Or Procédés, 413.
Longmans, Green & Co., Important Works on Chemistry, 301.
Nitrate Facts and Figures, 1928, 206.
New German Books, several, 206.
Où en est la Chimie Industrielle, 125.
Organic Synthesis, 126.
Organic Synthesis, 414.
Photochimies, 15.
Quantitative Analyse durch Electrolyse, 61.
Qualitative Analysis, 62.
Quarterly Magazine, 108.
Recent German Literature, 300.
Reports of the Progress of Applied Chemistry, 300.
Radiation in Chemistry, 239.
Recent German Books, 414.
Slag, Coke Breeze and Clinker as Aggregates, 30.
Standards and Tests for Reagent and C.P. Chemicals, 126.
South African Chemist and Druggist, 156.
Structure of an Organic Crystal, 190.
Science for You, 206.
Scientific Achievements in Illinois University, 366.
Solubility of Organic and Inorganic Compounds, 414.
Survey of Metal Industries, 366.
The British Journal Photographic Almanac, 93.
The Mystery and Lure of Perfume, 222.
The Composition of Water, 228

The Sixth Sense, and other Studies, 254.
The Chemistry of Chemotherapy, 254.
The Chemistry of Leather Manufacture, 300.
The Evolution of Scientific Thought from Newton by Einstein, 300.
The Modern Calorimeter, 301.
Text Book of Organic Chemistry, 318.
The Chemistry of Crude Drugs, 383.
The Rate of Living, 189.
U.S.A. and other Official Publications, 141.
Unsaturated Hydrocarbons in the Gases from the Carbonisation of Coal, 345.
Volumetric Analysis for Students of Pharmaceutical and General Chemistry, 190.
Weeds of South Africa, 125.

PATENTS.

Alkylguanidines, 32.
Aromatic Acide Anhydrides, 48.
Alkaloids, 95.
Azo Dyes, 191.
Acetic Acid, 239.
Aminonaphthonic Acid, 255.
Aniline Disulphonic Acid, 272.
Acetic Acid, 336.
Acyl and Alkyl Phenols, 367.
Calcium Formaldehyde-Sulphoxylate, 80.
Containers for Acids, 207.
Flavanthrone Derivatives, 158.
Hydrocyanic Acid : Cyanamides, 144.
Hydrochloric Acid, 303.
Lead Salts, 416.
Organic Acids, 351.
Potassium Ammonium, 384.
Phosphoric Acid, 64.
Synthetic Resins, 176.
Sulphuric Acid, 223.
Sulphuric Acid, 287.
Sulphuric Acid, 319.
Thiuramdisulphides, 16.
4-Amino-2-Benzoylbenzoic Acid, 111.
1-(2^1-Carboxyphenyl)-Anthraquinones, 128.
Trade Marks, 16, 32, 48, 61, 96, 112, 128, 144, 160, 207, 224, 240, 256, 288, 303, 320, 336, 352, 368, 384.

286
3 J
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